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The Engineer.

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The Engineer

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PUBLIC NOTICES

MAINS.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 5th February, 1929, for SUPPLYING and LAYING C.I. GAS and WATER MAINS, &c., at the National Physical Laboratory, Teddington, Middlesex.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 721

The Director - General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—

SCHEDULE 1.—62 PAIRS of DISC WHEELS with AXLES, and 600 DISC WHEELS for ROLLING STOCK.
SCHEDULE 2.—CRANK and STRAIGHT AXLES for LOCOMOTIVES.
SCHEDULE 3.—1040 STEEL TYRES for ROLLING STOCK.
SCHEDULE 4.—22 SETS of CYLINDERS for LOCOMOTIVES.

Tenders due as follows :—
Schedule 1, 25th January, 1929.
Schedules 2 and 3, 29th January, 1929.
Schedule 4, 1st March, 1929.
Forms of Tender available from the above at a fee (which will not be returned) of 5s. for each schedule. 733

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/732.—CIVIL ENGINEER REQUIRED by the GOVERNMENT of CEYLON for appointment as Irrigation Engineer for three years' service and prospect of permanency. Salary £500, rising to £900 a year by annual increments of £40 (£600 a year on attaining 30 years of age). Free quarters and free passages provided. Candidates, unmarried, 26 to 31 years of age, must have passed examination to qualify for Associate Membership of the Institution of Civil Engineers or hold professional qualifications recognised by the Institution as exempting from Parts A and B of that examination, and have had at least three years' practical experience on Waterworks, Drainage or Harbour and Dock Works.

M/1271.—ENGINEERING DRAUGHTSMAN REQUIRED by the GOVERNMENT of BRITISH GUIANA for the PUBLIC WORKS DEPARTMENT for two years' service in the first instance and possibility of permanency. Salary £500, rising to £600 a year by annual increments of £25. Free passages for the officer appointed and, if married, for wife and children, not exceeding five persons in all. Candidates, aged 27 to 35, must have passed Sections A and B of the examinations for the A.M.I.C.E. or hold professional qualifications recognised by the Institution of Civil Engineers as exempting from those examinations. Must have had experience in designing Buildings and Engineering Structures, including the use of reinforced concrete and in plotting surveys and preparing estimates. The officer selected must be capable of taking charge of the drawing-office.

Apply at once by letter, stating age and full particulars of qualifications and experience, to The CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 720

R.A. 2661.

Ministry of Transport. ARTERIAL ROADS, GREATER LONDON.
NORTH CIRCULAR ROAD, ESSEX.
WADHAM-ROAD, WALTHAMSTOW.
CONSTRUCTION OF A BRIDGE OVER THE LONDON AND NORTH-EASTERN RAILWAY, &c.

The Minister is prepared to receive TENDERS for the CONSTRUCTION of the above-mentioned BRIDGE and APPROACHES of REINFORCED CONCRETE, with APPROACH EMBANKMENTS and DIVERSIONS of PARTS of ADJACENT ROADS, and a small WIDENING at Wadham Lodge Farm, and including the maintenance of railway and road traffic through the site of the works.

Forms of Tender, conditions of Tender, conditions of contract, bills of quantities and specification may be obtained from, and drawings may be inspected at, the office of the Chief Engineer, Roads Department, Ministry of Transport, 7, Whitehall-gardens, S.W. 1, on and after the 21st January, 1929, upon payment of a deposit of £25.

This amount will be returned to the tenderer if his Tender is a bona fide one and has not been withdrawn prior to the definite acceptance of a Tender by the Minister.

Preference will be given to contractors who have had previous experience of similar work.

Tenders, on the official form, accompanied by a fully priced bill of quantities and schedules of prices, and enclosed in a sealed envelope, endorsed "Tender for the Construction of Wadham-road Bridge, &c.," must reach the undersigned by 10 a.m. on Monday, the 11th February, 1929.

The Minister does not bind himself to accept the lowest or any Tender.

Dated this 4th day of January, 1929.
H. H. PIGGOTT,
Roads Department, Assistant Secretary.
Ministry of Transport. 675

The High Commissioner for India REQUIRES an ASSISTANT ENGINEER INSPECTOR (Mechanical) for service in England. The post is on a non-pensionable basis and will be held in the first instance on probation for two years, during which period the services of the incumbent may be dispensed with at one month's notice. Thereafter service will be terminable by six months' notice on either side.

Salary £150, rising by annual increments to £300. Prospect of £310, rising by annual increments to £400 by promotion to Inspector. These salaries carry a variable cost-of-living bonus on the Civil Service scale. At present the bonus on £150 amounts to £76.

Candidates should be 28 to 35 years of age, have good technical and shop training and have held some position of responsibility. All-round rather than specialised experience is desirable. Preference given to A.M.I. Mech. E. or equivalent. Previous inspection experience not essential.

Applications, stating age, training and experience, and enclosing copies of recent testimonials, to be sent to the DIRECTOR-GENERAL, India Store Department, Belvedere-road, Lambeth, S.E. 1, not later than the 1st February, 1929. 698

PUBLIC NOTICES

University of London.

A COURSE of FOUR LECTURES on "SOME APPLICATIONS OF PHYSICAL CHEMISTRY TO STEEL MANUFACTURE" (with lantern illustrations) will be given by Dr. ANDREW McCANCE, D.Sc. (Managing Director, Clyde Alloy Steel Co., Ltd.), at the IMPERIAL COLLEGE, ROYAL SCHOOL OF MINES (Princ.ce Consort-road, S.W. 7), on JANUARY 23rd, 24th, 30th, and 31st, at 5.30 p.m. At the First Lecture the chair will be taken by F. W. Harbord, Esq., C.B.E. (late President of the Iron and Steel Institute).

ADMISSION FREE, WITHOUT TICKET.
EDWIN DELLER,
639 Academic Registrar.

Gold Coast.

A PRINCIPAL is REQUIRED for the Government Technical School, Accra, Gold Coast. Candidates should be University graduates in Engineering or should possess some similar recognised technical qualification, and should be not more than 35 years of age. Salary at the rate of £960 per annum with a duty allowance of £96 per annum, payable whilst the Principal is on duty in the Colony. Free first-class passage and free quarters provided.—Further information may be obtained on application to C.A. (D), the SECRETARY, Board of Education, Whitehall, London, S.W.1. Scottish candidates should apply to (D), the SECRETARY, Scottish Education Department, Whitehall, London, S.W. 1. The list of applications will close on 28th January. 583

City of Leicester Education COMMITTEE.
COLLEGE OF TECHNOLOGY.
(RINCIPAL: L. W. KERSHAW, B.Sc., A.M. Inst. C.E., F.G.S.)

APPLICATIONS are INVITED for APPOINTMENT as FULL-TIME LECTURER of ELECTRICAL ENGINEERING—up to A.M.I.E.E. and B.Sc. Standard—for the Day and Evening Classes.

Candidates should have a good Honours Degree in Electrical Engineering and practical works experience.

The person appointed may be required to teach both physics and mathematics to students of the Engineering Department.

Salary in accordance with the Burnham Scale.

Applications, together with copies of testimonials, should reach the Registrar, College of Technology, Leicester, not later than 31st January, 1929.

F. P. ARMITAGE,
695 Director of Education.

PUBLIC NOTICES

Sunderland Education Com- MITTEE.
THE TECHNICAL COLLEGE.
DEPARTMENT OF MECHANICAL AND CIVIL ENGINEERING.

The Committee invite APPLICATIONS for the POSITION of HEAD of the MECHANICAL and CIVIL ENGINEERING DEPARTMENT. Applicants must possess an Honours Degree and have had good drawing-office and works experience.

The standard of the full-time day courses is that required for an Honours University Degree, and that of the part-time evening courses for Senior and Advanced Students from the marine engineering drawing-offices and works of the district desiring the Ordinary and Higher National Certificates of the Institution of Mechanical Engineers. Experience in all types of prime movers, steam and oil, is desirable.

Salary scale £600-£25-£700, less 5 per cent. for superannuation.

Application forms can be obtained from the undersigned and should be returned not later than Saturday, 9th February, 1929.

HERBERT REED,
Chief Education Officer.
Education Offices,
15, John-street, Sunderland,
7th January, 1929. 667

Portsmouth Municipal College.
ENGINEERING DEPARTMENT.

Head of Department: R. C. PRESCOTT, M.Sc. (Tech.), M.I. Mech. E.

The Committee invite APPLICATIONS from Qualified Civil Engineers for the POST of LECTURER in CIVIL ENGINEERING and BUILDING TRADES WORK in the Engineering Department of the Municipal College. Candidates should be Graduates in Civil Engineering, with practical experience, and preferably with the A.M.I.C.E. qualification.

Salary in accordance with the Burnham Scale.

Application forms should be returned not later than January 25th, 1929.

Full particulars and form of application may be obtained from the Secretary at the Municipal College, Portsmouth.

H. E. CURTIS,
Secretary.
Offices for Higher Education,
The Municipal College,
Portsmouth. 702

PUBLIC NOTICES

Bengal-Nagpur Railway Com- PANY, LIMITED.

The Directors are prepared to receive TENDERS for :
A.—STEEL ANGLES and BARS.
B.—AXLE-BOXES and FITTINGS.
C.—BEST YORKSHIRE IRON.
D.—CARRIAGE and WAGON TYRES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Tuesday, 15th January, 1929.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Monday, 28th January, 1929.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
E. C. VOLKERS,
693 Secretary.

Borough of Basingstoke.
ELECTRICITY DEPARTMENT.

The Electricity Committee invite TENDERS for the SUPPLY, DELIVERY and ERECTION of :—
ONE HEAVY OIL ENGINE Direct Coupled to a 800-kW Three-phase, 50-Period ALTERNATOR.

Specifications, general conditions and form of Tender may be obtained from Mr. F. Swarbrick, Borough Electrical Engineer, Electricity Works, Basingstoke, on payment of a fee of One Guinea for each specification, which will be refunded on receipt of a bona fide Tender.

Extra copies may be obtained at Ten Shillings each, which sum will not be returnable.

Tenders, endorsed "Generating Plant," must be delivered to the undersigned not later than first post on Tuesday, January 29th, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

F. H. SMITH, LL.D.,
Town Clerk.
Municipal Buildings, Basingstoke,
January 14th, 1929. 697

Cleethorpes Urban District COUNCIL.
TENDERS FOR WATER FILTRATION AND PURIFICATION PLANT.

The above Council invite TENDERS for the INSTALLATION of a FILTRATION and PURIFICATION PLANT in connection with their Sea Water Bathing Pool.

Plans, specification, and full particulars may be obtained on application to Leonard W. Pye, A.M.I.C.E., Engineer and Surveyor, Council Offices, Cleethorpes.

Tenders to be delivered to the undersigned not later than Saturday, 16th February, 1929.

ALBERT S. BARTER,
Clerk to the Council.
Council Offices, Cleethorpes,
12th January, 1929. 689

Royal State Railways of Siam.
NOTICE.

Sealed TENDERS for the SUPPLY of 51 BOGIE WAGONS for B.E. 2471 will be received by the SUPERINTENDENT OF STORES, Royal State Railways of Siam, until Fourteen o'clock on April 16th, 1929.

Blank Tender forms, general conditions and specifications can be obtained from Messrs. Sandberg, 40, Grosvenor-gardens, London, S.W. 1, upon payment of £1 10s. per set, which sum will not be refunded.

Right is reserved to reject any or all Tenders. 715

Parish of Willesden.
GENERATING SET FOR SALE.

The Guardians of the above-named Parish invite OFFERS for ONE STEAM-DRIVEN GENERATING SET, consisting of 46 B.H.P. Compound Engine, by J. Howden and Co., steam pressure 130 lb. per square inch, direct coupled to Continuous Current Compound-wound Dynamo, output 140 amperes at 210 volts, mounted on combined bed-plate.

The set is in good running order and can be seen working on application to the Chief Engineer, Park Royal Hospital, Acton-lane, Willesden, N.W. 10.

Offers should be addressed to
J. HUTTON HAYLOR,
Clerk to the Guardians,
409, High-road, Brondesbury, N.W. 6,
and must be received not later than February 8th, 1929. 691

The County of London Electric SUPPLY COMPANY, LIMITED.

The above Company has FOR DISPOSAL, either as a whole or in separate lots, the complete EQUIPMENT of their City-road Generating Station, comprising A.C. and D.C. Reciprocating and Turbine Generating Plant, Boilers, Auxiliaries, Coal-handling Plant, &c.

Schedule of plant and orders to view may be obtained by interested parties on application in writing to the undersigned.

JOHN C. DALTON,
Manager and Secretary.
The County of London Electric Supply Co., Ltd.,
County House, 46/47, New Broad-street,
London, E.C. 2. 694

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PUBLIC NOTICES

RAILWAYS.
4-WHEELED WAGONS (BROAD GAUGE).

The Consulting Engineers to the Gaekwar's Baroda State Railways (Messrs. RENDEL, PALMER and TRITTON, 12-14, Dartmouth-street, Westminster S.W. 1) invite TENDERS for 15 COVERED and 10 OPEN GOODS WAGONS.

Specifications and Tender forms can be obtained from their office on payment of 5s. (which will not be returned).

Tenders must be submitted not later than Noon on 8th February, 1929. 719

Administrative County of LONDON.

APPLICATIONS are INVITED for the POSITION of DISTRICT INSPECTOR of SCHOOL in the Education Officer's Department.

SALARY.—£500 a year, rising by annual increments of £25 to £600 and thence by annual increments of £50 to a maximum of £800 a year, with a fluctuating temporary addition. At the present time the total commencing salary is £659.

DUTIES.—To conduct and assist in conducting the inspection of schools, colleges, and institutes within the area and to inspect and to advise upon instruction in technical subjects. Candidates should possess engineering or similar technical qualifications as well as teaching experience. Apply to the Education Officer (C.1.), The County Hall, Westminster Bridge, S.E. 1. Stamped addressed envelope necessary for form of application, to be returned not later than 11th February, 1929.

Canvassing disqualifies.

MONTAGU H. COX,
717 Clerk of the London County Council.

Indian State Railways.

THREE ASSISTANT ENGINEERS are REQUIRED for service in the Mechanical Engineering Department of the Indian State Railways.

Age, not more than 25 years.

QUALIFICATIONS.—Candidates should have received a good general and technical education and have passed the Associate Membership Examination of the Institution of Civil Engineers, or hold a Degree or Diploma granting exemption from Sections "A" and "B" of this Examination; should have served at least 4 years as pupil or apprentice in the locomotive workshops of a British Railway Company or firm of Locomotive Builders of repute, and at least 1 year in the drawing-office, and possess an intimate knowledge of the planning, progressing and costing methods adopted in workshops of up-to-date commercial firms.

SALARY.—Initial salary Rupees 375 a month (plus Rs. 150 overseas pay for an officer of non-Asiatic domicile). Salary payable from date of landing in India, subject to rules in force. Leave, Provident Fund and gratuity in accordance with the rules applicable to officers of the Indian State Railways.

Agreement for 3 years in first instance, but service to be extensible beyond that period with the consent of both parties concerned.

A first-class passage to India will be provided on appointment.

Application must be made by letter only, and all applicants must state their age, whether married or single, and give full particulars (in chronological order) of their education, training and subsequent experience, stating the names of railways or contractors by whom they have been employed, and giving details of the work employed upon, with dates in each case. Details should also be given of any previous experience abroad, together with copy of leaving certificate.

Applications, which should be accompanied by COPIES ONLY of testimonials, must be addressed to the undersigned not later than 31st January, 1929.

Messrs. RENDEL, PALMER and TRITTON,
12/15, Dartmouth-street,
684 Westminster, S.W. 1.

Shanghai Municipal Electricity DEPARTMENT.
STAFF APPOINTMENTS.

The Electricity Department of the Council REQUIRES the SERVICES of ONE SYSTEM CONTROL ENGINEER, TWO ASSISTANT SHIFT CHARGE ENGINEERS, and TWO DISTRIBUTION ENGINEERING ASSISTANTS.

(A) SYSTEM CONTROL ENGINEER.—The successful applicant would, whilst on shift, be responsible for directing all switching and operating on the distribution system. In order to keep familiar with the system he may be required to act for alternate periods as Distribution Engineering Assistant.

Applications will only be considered from those having the following qualifications:—

AGE.—Not exceeding 35 years.

TECHNICAL EDUCATION.—Equivalent to I.E.E. Examination for Associate Members.

PRACTICAL TRAINING.—Must have served an apprenticeship with some electrical engineering concern of good standing.

EXPERIENCE.—Must have had experience with maintenance and operation of large E.H.T. switchgear, transformers, relays and protective systems. Previous experience of control work advisable, but not essential.

The commencing salary will be Tls. 450 per month (ultimately rising to Tls. 630 per month).

(B) ASSISTANT SHIFT CHARGE ENGINEERS.—The duties attaching to these appointments are those connected with the operation of shifts in a large modern power station.

Applications will only be considered from those having the following qualifications:—

AGE.—Not to exceed 30 years and preferably single.

TECHNICAL EDUCATION AND ATTAINMENTS.—A knowledge of electrical and mechanical engineering such as will enable the candidates to pass the I.E.E. Examination for election as Associate Members.

PRACTICAL ENGINEERING TRAINING.—Preferably mechanical and electrical; alternatively, mechanical only, in the works of a well-known engineering firm.

EXPERIENCE SUBSEQUENT TO TRAINING.—Preferably as Junior or Assistant Shift Engineers in large modern power stations, and having served in this capacity as immediate juniors to Charge Engineers in the control and scientific operation of power station plant from boiler room to control room. A knowledge of pulverised fuel working will be regarded as an advantage, but is not essential.

The commencing salary will be Tls. 350 per month, rising to Tls. 400 in three years, ultimately rising to a maximum of Tls. 580 per month.

(C) DISTRIBUTION ENGINEERING ASSISTANT.—Successful applicants would probably be employed in the Sub-station Section, which is responsible for the erection, operation and maintenance of all sub-station apparatus.

Applications will only be considered from those having the following qualifications:—

AGE.—Not exceeding 30 years.

TECHNICAL EDUCATION.—Equivalent to I.E.E. Examination for Associate Members.

PRACTICAL TRAINING.—Must have served an apprenticeship with some electrical firm of good standing, manufacturing heavy plant. Experience of manufacture and erection of H.T. switchgear, &c., is essential, and experience in the operation and maintenance of plant on a moderately large supply system would be considered an advantage.

The commencing salary will be Tls. 400 per month.

GENERAL.—Each appointee will be provided with free medical attention and will participate in the Council's superannuation fund and other benefits, which will be explained to candidates.

The present value of the Tael is approximately 2s. 7d.

The first engagement will in each case be for a period of three years, and free second-class passage out and home will be provided.

The maximum system load at present is 100,000 kW, the annual output is 530 million units and the generating plant capacity is 161,000 kW.

Applications should be submitted in writing only, giving full particulars as to age, education, training, subsequent experience and present position held, together with copies of testimonials, and forwarded to C. S. Taylor, M.I.E.E., M.A.I.E.E., Deputy Engineer-in-Chief and Manager, c/o Messrs. Preece, Cardew and Rider, 8, Queen Anne's-gate, London, S.W. 1, not later than Friday, the 1st February, 1929. Envelopes should be marked with the letter "A," "B," or "C" corresponding to the appointment applied for.

T. H. U. ALDRIDGE,
M.I.E.E., M.I. Mech. E., Fel. A.I.E.E.,
Engineer-in-Chief and Manager.
16th January, 1929. 686

Government of the Commonwealth of Australia.

TENDER.

Lease of COCKATOO ISLAND DOCKYARD.

SHIPBUILDING AND ENGINEERING AND REPAIRING WORKS.

The Government of the Commonwealth of Australia is prepared to receive tenders for the Lease of Cockatoo Island Dockyard as a going concern for a term of 20 years with the option of renewal for a further term not exceeding 10 years.

The Dockyard is situated in the Harbour of Port Jackson, New South Wales, contiguous to the shipping centre of Sydney, and has an approximate area of 37 acres, with extensive deep-water frontage, including extensive wharf and fitting-out accommodation for vessels of the largest size, and is laid out with building slipways, shops, sheds, machines and all appliances and apparatus, tools, &c., necessary for the construction of naval ships and all types of passenger and cargo vessels, together with their Engines, Boilers and Auxiliaries. The Works are capable of handling all types of General Engineering Work and of turning out all classes of Iron, Steel and Brass Castings, also Heavy and Light Forgings.

GRAVING DOCKS. There are two Graving Docks, the largest of which is 690ft. in length by 88ft., the smaller being 478ft. 5in. by 58ft. 8in. in width.

SHIPYARD. The layout of the Shipyard comprises Mould Loft, Shipwrights' Shop, Platers' Sheds, Forge, Plumbers' and Sheet Ironworkers', Joiners' Shop, Boat-building Shop, Sawmill, Rigging and Sail Lofts, Paint Shop and Galvanising Shops, all equipped with the latest and most modern machinery and appliances capable of dealing with the largest class of work, including all classes of overhaul and repairs.

ENGINE WORKS. The layout of the Engine Works comprises Pattern Shop, Iron, Steel and Brassfoundries, Fitting Shop, Machine Shop, Brass Finishing Shop, Boiler Shop, Coppersmiths' Shop, Testing Shop, Smithery, Electrical Workshop, Tool Room and Laboratory. The shops are fully equipped with first-class machinery and are capable of dealing with new construction and repairs to all types of machinery.

POWER HOUSE. The Power House is complete with Generating Plant supplying the whole of the electric power, light, compressed air and hydraulic pumps required by the Graving Docks and various shops and machinery at the Dockyard.

STORE. A large modern Bulk Store of three floors is available for housing all materials and fittings, and each workshop is equipped with a small issuing store. There are separate Stores for Timber and Iron.

CRANES AND TRAMWAYS. The Wharves, Workshops and Shipbuilding Slipways are well equipped with all necessary Cranes. The Shops, Yards, and the whole of the premises have also a complete system of tramways installed.

OFFICES AND RESIDENCES. Substantially built and well-furnished Offices for the use of Administrative Staff, Clerks, Estimators, Ship, Engine and Electrical Draughtsmen, Foremen, Timekeepers, is available. House accommodation is provided for the use of Manager, Superintendents, Accountant, Caretaker and Police, &c.

FLOATING CRAFT. Floating Craft consists of Floating Workshop, Tugs, Launches, Hopper Barge, Floating Oil Tank, Punts, Landing Stages, &c.

PARTICULARS, together with form of Tender, conditions of Tender, conditions of contract, together with schedule and plans of Dockyard, can be obtained by bona fide tenderers (principals only) at the office of the High Commissioner, Australia House, Strand, London, W.C. 2; the Prime Minister's Department, Canberra, F.C.T.; or at Cockatoo Island Dockyard, Sydney, N.S.W. A charge of £50 will be made per set of these documents, which sum will be refunded on their return accompanied by a bona fide Tender.

Sealed Tenders, endorsed "Tenders for Lease of Cockatoo Island Dockyard" and addressed to the Official Secretary, High Commissioner's Office, Australia House, Strand, London, W.C. 2; or to the Secretary, Prime Minister's Department, Canberra, F.C.T., Australia, to be lodged at the office of the High Commissioner, London, or of the Prime Minister, Canberra, F.C.T., respectively, not later than Twelve Noon on 30th March, 1929. The highest or any Tender not necessarily accepted.

J. G. McLAREN,
Secretary, Prime Minister's Department.
CANBERRA, F.C.T.

YARROW HOME and HOSPITAL FOR CHILDREN BROADSTAIRS.

For the Early & Preventive Treatment of Disease & Convalescence after illness.

The Hospital is intended for the children of Members of the Institution of Civil Engineers, the children of architects, artists, authors, clergymen, members of the medical, legal, and other professions, members of scientific societies, officers of the Navy, Army, and Royal Air Force, officers of the Merchant Navy, schoolmasters and university professors.

Accommodation is provided for 50 Boys between the ages of 4 and 12 years, and 50 Girls between the ages of 4 and 14 years. In special cases the age limits may be raised to 14 for Boys, and 16 for Girls.

Fee 21/- per week, or as may be arranged, and travelling expenses.

Particulars can be obtained from the Secretary:—

116, Victoria Street, Westminster, LONDON, S. W. 1.

PUBLIC NOTICES

Borough of Keighley.

APPOINTMENT OF WATER ENGINEER.

APPLICATIONS are INVITED from duly qualified Water Engineers for the above APPOINTMENT at a commencing salary of £500 per annum.

The post is a designated one under the Local Government and other Officers' Superannuation Act, 1922, and the appointment will be made subject to medical examination.

Applications, on form to be obtained from the undersigned, marked "Water Engineer" and accompanied by copies of three recent testimonials, must be delivered to me not later than the 25th January, 1929.

S. WALKER,
Town Clerk.

Town Hall, Keighley.
4th January, 1929. 620

Mersey Docks and Harbour BOARD.

ENGINEERING ASSISTANT TO THE MARINE SURVEYOR AND WATER BAILIFF.

APPLICATIONS are INVITED for APPOINTMENT to the POST of ENGINEERING ASSISTANT to the Marine Surveyor and Water Bailiff.

Candidates must not be over 40 years of age; must hold a Board of Trade First Class Certificate as an Engineer, and have had experience in ship construction and knowledge of motor machinery.

Salary £500 per annum. Applications, with copies of references and particulars of training and experience to be addressed to the undersigned not later than January 31st, 1929.

L. A. P. WARNER,
General Manager and Secretary.

Dock Office, Liverpool,
January 2, 1929. 617

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

COMMERCIAL ENGINEER, with Experience in Oil Engines and Electrical Equipment, WANTED for our Japan office.—Apply, stating age, experience and salary required, to ATLAS DIESEL CO., Ltd., 35, Surrey-street, London, W.C. 2. 622 A

SITUATIONS OPEN (continued)

WANTED, a First-class Practical and Technical Man as prospective WORKS REPAIR SHOP FOREMAN. Age 25 to 33 or thereabouts.

The shop is engaged on mill repairs of a miscellaneous character.

The successful candidate must have an excellent knowledge of all shop tools. He must be able to make his own working drawings and to exercise strong and intelligent control over men, materials and work sequence.

Address in the first instance, 682, The Engineer Office. 682 A

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For continuation of Small Advertisements see page 4.

A Seven-Day Journal

The Channel Tunnel.

ONCE again a considerable volume of interest is being displayed in the scheme for connecting England and France by a railway tunnel. Exactly sixty years ago, as our own pages show, the scheme was being no less actively debated. At various periods in the interval attention to it was revived, and at one time, in 1881, work on the tunnel was actually begun on both sides of the Channel, a mile and a quarter of its length being driven from each coast. The French are entirely in favour of the construction of the tunnel, but on this side the Committee of Imperial Defence, having before it all the evidence in favour of and against the tunnel provided by the war, has definitely decided against it. Many still hope to see that decision revoked. A recent canvass of members of the House of Commons and House of Lords showed that out of 342 members 179 were in favour of the scheme, 53 were opposed to it, and 110 were neutral. Within the past week Viscount Cecil of Chelwood has described as fantastic the fears expressed in some quarters that the tunnel would carry a threat of invasion to this country. His argument was that if an unprovoked attack in this country were contemplated by a continental power, the air and not the tunnel would be the means employed. Mr. F. A. Brant, head of the Southern Railway's Continental Department, has also spoken during the past week on the scheme. He was completely in favour of it. He held that for many years to come the railways would be able to hold their own against cross-Channel air services. He was not prepared to say that the tunnel would pay at the outset, but its immense value to the country by bringing over thousands of visitors who would never come otherwise would justify any financial support on the part of the Government.

The Restrictions of the Gas Industry.

ON Thursday of last week, January 10th, the National Fuel and Power Committee — Lord Melchett's Committee appointed by the Board of Trade in August, 1926—issued a report prepared by a sub-committee, presided over by Mr. Frank Hodges, which had been charged with the task of making recommendations concerning the gas industry, and in particular to consider proposals for amending the existing legislation relating to gas. The sub-committee states that it was impressed by the representations made before it by the National Gas Council to the effect that the industry should be freed, as soon as possible, from the irksome conditions under which it is at present forced to work. Accordingly the sub-committee recommends that legislation to the desired end should be promoted without delay. The principal conditions which at present are found irksome relate to the costly and cumbersome procedure which statutory gas undertakings have to institute in order to obtain increased powers in such matters as the amount of capital which may be raised, the method of obtaining capital, and the making of arrangements for joint working with neighbouring undertakers. It is stated that certain undertakings are to-day operating under unnecessarily arduous restrictions imposed many years ago, and are hampered in their operations by the fact that the cost of obtaining authority even to raise fresh capital to meet extensions of business would reflect definitely on the cost of supplying gas. The sub-committee also recommends that simplified procedure should be provided to enable gas undertakings to obtain from the Board of Trade a Departmental Order empowering them to institute the two-part tariff system as an alternative method of charge, and to make such amendments as may be necessary to the existing regulations governing a company's authorised dividend consequent on departure from the flat-rate system of charge.

The R.A.F. Far East Flight.

WE have received this week from the Air Ministry the third instalment of the log of the Royal Air Force Far East Flight. It covers the concluding stages from Singapore round Australia and back to Singapore. The flight was composed of four Supermarine-Napier Southampton flying boats, and was under the command of Group Captain H. M. Cave-Brown-Cave. It left Plymouth on October 17th, 1927, and proceeded across Europe to Athens and thence, *via* Egypt and Alexandretta, across Irak and down the Persian Gulf to Karachi, which was reached on November 18th, 1927. The second stage of the flight was begun on December 14th. It covered a flight round the whole coast of India to Calcutta, and thence along the coast of Burma and Indo-China to Singapore, which was reached on February 28th, 1928. The flight left Singapore on May 21st, and passing over the Dutch East Indies, struck southwards for Australia. Passing round the West Australian coast to Perth, it proceeded across the Great Australian Bight to Adelaide, and thence flew to Melbourne, which was reached on June 29th. Melbourne was left on July 30th, and the flight following the New South Wales and Queensland coasts, passed by way of Port Darwin in North Australia across to the Dutch East Indies and so returned to Singapore, which was reached on September 15th. The distance covered by the flight from the time it left England until it returned to Singapore was 22,600 statute miles. Until the machines reached Melbourne they were not once under cover. At Sydney, the log records, the Press was surprised that the flight had no sensational information to give. The truth is that beyond an accumulator catching fire, a temporary failure of an oil cooking stove, a punch received from a careless refuelling lighter and some trouble from the adherence of barnacles to the hull, the undertaking passed off completely without untoward incident or accident. Since returning to Singapore the flight has made a farther cruise of more than 4500 miles to Hong Kong. A handsome souvenir of the cruise composed of photographs of the men and machines who took part in it, and a map and condensed log of the journey, has been sent to us by the Supermarine and Napier companies jointly.

Engineers' Wages.

ON the authority of Mr. W. Sherwood, the President of the Federation of Engineering and Shipbuilding Trades, it was announced this week that a conference of the executives of the engineering trade unions, of which there are over forty, is to be held in London towards the end of February to consider the policy to be adopted in pursuit of a fresh claim for a wages advance. Following the failure last year of the unions to obtain a national increase of wages, a special committee was appointed to consider the position of the various sections of the engineering industry separately. This report is still confidential, but it is understood that it alleges that some sections, particularly the motor and electrical and some portions of the metal industries, have experienced an improvement in trade, and, while they have not met with a boom, have recovered their position sufficiently to justify their being asked to concede a wages advance. After the report has been considered, the conference of executives will be called upon to decide whether the unions shall prosecute another national claim, or endeavour to obtain advantages in the more prosperous sections of the industry. If the sectional policy is adopted, it will introduce a new note into the negotiations between the unions and the employers. The employers are likely strongly to oppose district or sectional advances, and the unions themselves have to consider the possibility of discontent among their members if such advances were secured. Even although the employers were willing to grant them, the fact that they might result in a difference in wages between two men doing similar work in the same district for the one firm, but in different departments, has to be considered, a condition that would almost certainly lead to internal trouble.

New Hamburg-Amerika Line Developments.

FOR some months past it has been generally understood that failing some agreement with the North German Lloyd Company regarding the operation of the two fast liners "Bremen" and "Europa," the Hamburg-Amerika Line would take steps to bring its own fleet more into line with modern Atlantic travel requirements. According to news from Berlin, the first steps in this direction have already been taken, and it has been decided to re-engine and modernise the four 20,000-ton liners of the "Albert Ballin" class, so that they will be capable of a speed of 20 knots, and will make the passage from a Channel port to New York in seven days. These ships include the "Albert Ballin," the "Deutschland," the "Hamburg," and the "New York." The passenger accommodation of the earlier ships is to be brought up to the standard of the last-named liner. All being well, the new turbines and boilers, together with propellers and shafts, will be ready for installation during the present year, so that a weekly service to New York can be begun with the re-engined liners early next year. The existing turbines will be employed in 15-knot passenger and cargo ships of 16,000 tons, of which two have been ordered from Blohm and Voss, in Hamburg. It is expected that the final steps to be taken will not be announced until the question of the compensation for the property of the company seized in America during the war has been definitely settled, but part of the new programme is said to provide for the building of a fast luxury Atlantic liner, with a speed higher than that of the two North German Lloyd ships. A complete description of the liner "Albert Ballin" and her propelling machinery will be found in the issues of THE ENGINEER for September 14th and 21st, 1923.

600 lb. Pressure Boilers for London.

WE are able to state that the Board of the London Power Company, Ltd., has placed with Babcock and Wilcox, Ltd., the order for the entire steam-raising plant for its new super-power station at Battersea. The boilers will consist of six units of the C.T.M., or cross-tube marine, type, each of which will be designed to evaporate 250,000 lb. of water per hour under normal working conditions, with a maximum continuous rating of 312,000 lb. per hour. The working pressure will be 600 lb. per square inch, which is stated by the makers to be the highest pressure so far adopted in Great Britain for a plant of this large size. The exact degree of superheat is not given, but the pressure of steam at the turbine stop valves is 570 lb., with a total temperature of 850 deg. Fah. Particulars of the two 67,250-kW turbines, one of which will be supplied by the British Thomson-Houston Company, Ltd., and the other by the Metropolitan-Vickers Electrical Company, Ltd., will be found in a Journal Note in our issue of December 14th. The boiler plant will embody the firm's latest practice. The boilers will be fired by mechanical stokers of Babcock design, the exact details of which have yet to be fixed. Each of the six boilers will be complete with a high-duty steel tube economiser, an integral steam superheater, and a tubular air heater, while the furnace walls are to be of the "Bailey" water-cooled type. All the accessory plant, which includes calorised soot blowers of the "Diamond" pattern, as well as ash-handling plant and other equipment, will be supplied by Babcock and Wilcox, Ltd. The contract is stated to be the largest single contract every placed by a British undertaking for steam-raising plant.

The Railway Trade Unions.

THE largest of the three railway unions, the National Union of Railwaymen, has for long been in favour of a complete amalgamation with the Railway Clerks' and the Locomotive Engineers' and Firemen's Unions, but both these second named societies have equally been opposed to a fusion. The Trades Union Council's general policy of promoting amalgamation wherever possible has led to the discussion of a compromise between the three railway unions. The proposed scheme now being considered covers the establishment of a National Joint Council for the three unions, which would co-ordinate their activities and render possible joint consultations and action. In the past there has been some degree of consultation between them on important issues, but when a crisis has arisen they have not always taken the same line of action. The fact that a National Joint Council is now proposed suggests that the National Union of Railwaymen realises that a complete amalgamation is not yet possible, and that a compromise must be sought.

A Special Lifeboat for English Channel Service.

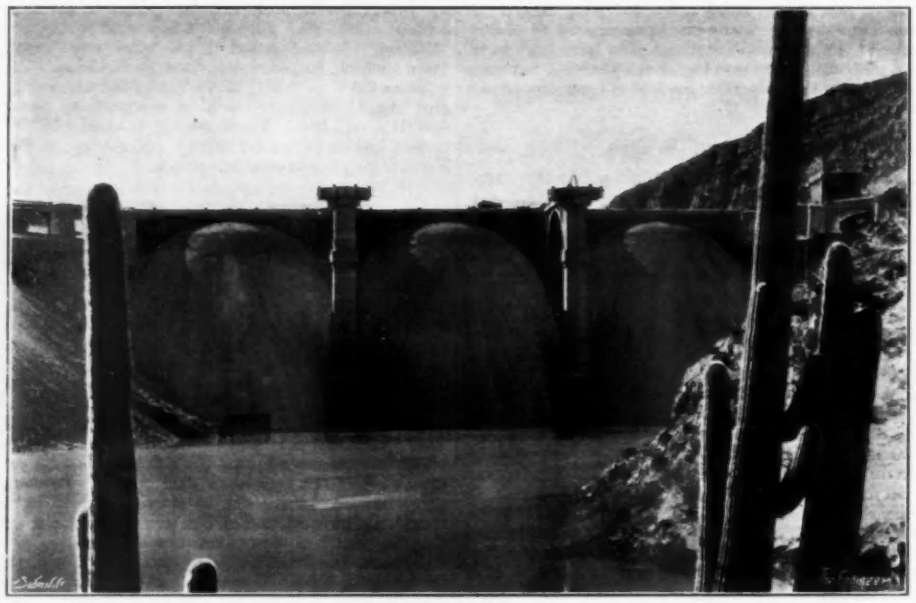
A MOTOR lifeboat, the fastest, it is stated, in the world, is to be designed and built for the Royal National Lifeboat Institution, and will be stationed at Dover, its purpose being to go to the help of aircraft which may come down while crossing the Channel, and also to be at the service of the cross-Channel steamers. The new boat, which is being built by John I. Thornycroft and Co., Ltd., at Hampton, will have a length of 64ft. with a beam of 14ft. She will be designed for a speed of 17 to 18 knots, and will be propelled by two 375 B.H.P. Thornycroft petrol engines, similar in type to those used in the C.M.Bs. The cylinder bore is 5¾in., with a stroke of 7in., and the twelve cylinders are arranged in pairs in V form, the designed running speed being 1550 r.p.m. Each engine is fitted with reversing gear. The new lifeboat will have two cabins, with a total accommodation for about fifty persons. The auxiliaries will include an electrically operated capstan, a searchlight, and a line-throwing gun. A departure is to be made by fitting the new boat with a wireless telephony equipment, designed to receive and send messages over a distance of about 50 miles. The new lifeboat will not be suitable for work on the Goodwin Sands or close inshore, and services of this type will be dealt with by the existing lifeboats at Ramsgate, Deal, Walmer and Folkestone.

The New Chilean Submarines.

AN interesting ceremony took place at the Naval Construction Works of Vickers-Armstrong's, Ltd., Barrow-in-Furness, on Tuesday last, January 15th, when two of the three submarines for the Chilean Government were launched on the same tide. It is over twenty years since a double launch of the kind was made, and in that period the displacement of a submarine has increased to five times that of the submarine of twenty years ago. The first of the Chilean submarines, the "Capitan O'Brien," took the water last October. The two ships just launched were named the "Capitan Thompson" and the "Almirante Simpson." All three ships bear the names of famous British officers who served in the Chilean Navy, and they are of the British "O" class type, similar to the submarines built by Vickers-Armstrong's for the British and Australian Governments. In a speech delivered after the launching ceremony, Commander C. W. Craven, managing director of the Barrow, Elswick and Erith Works of Vickers-Armstrong's, Ltd., announced that his firm had received the order for a submarine depôt ship from the Chilean Government, and also a gunboat for Siam. It is very satisfactory to learn that nearly 13,000 men are now being employed at Barrow, and that there is prospect of continued employment. The 20,000-ton Orient liner "Orontes" will be launched towards the end of next month. Other work in hand includes four British submarines of the "P" class, together with the destroyer "Arrow."

The Coolidge Dam in Arizona.

THE reinforced concrete multiple-dome arch, now nearly completed across the Gila River in Arizona, has the distinction of being the first of a new type of concrete dam. Several multiple-arch dams, each consisting of a series of inclined arches sprung between a succession of piers, the arches thus sustaining the vertical weight of water as well as its horizontal pressure, have been built. An example of this construction is the Lake Pleasant Dam, also in Arizona, which has a length of 2146ft., and consists of a series of inclined arches of 44ft. clear span, separated by hollow piers or buttresses 16ft. wide, so that the spacing is 60ft. between centres of piers. The height of this Lake Pleasant Dam is about 170ft.



UPSTREAM FACE OF DAM

But in the Coolidge Dam, which is named after the President of the United States, the span is 180ft. between centres of piers and the inclined axis of each span is curved in the vertical plane, so that a dome-shaped structure resembling an egg shell, cut in half along its major axis, has been formed. The special features of the design, therefore, are the unusual length of span between piers and the curving of the shell in both horizontal and vertical planes, so as to form a dome instead of a simple inclined barrel arch.

The Coolidge Dam, which is illustrated herewith and in our Supplement of to-day, and which is 250ft. high and 600ft. long on the crest, comprises three domes of 180ft. span, sprung between two piers or buttresses, and two short cut heavy abutments in the cliff walls of the canyon. In each abutment is a spillway, 166ft. wide, narrowing to a 60ft. inclined channel, these channels curving down to the river bed. The level of the overflow dam or weir at the head of each spillway is 20ft. below the crest of the main dam. A roadway crosses the dam in a straight line, supported by reinforced concrete arches, which rest on the piers and abutments; but it curves back over the abutments and is carried across the 166ft. spillway openings by three concrete arched spans. At the site of the dam the canyon is about 300ft. wide at the bottom, and 700ft. at the elevation of the crest of the dam. Each spillway has a capacity of 60,000 cusecs, with a full depth of 20ft. of water on the crest of the weir.

In 1924 the construction of the dam was approved by the United States Congress, as the essential feature of a project for irrigation, flood control and power development. Its cost was not to exceed £1,100,000. It is to form a reservoir providing for irrigation on about 100,000 acres of lands which are held as a reservation for the settlement of certain Indian tribes. The project is therefore under the jurisdiction of the Department of the Interior. The reservoir will have a storage capacity of 1,300,000-acre-feet, and will restrain or control the sudden and short or flashy floods in the Gila River, which at times reach a flow of more than 100,000 cusecs. In addition, the dam will include a hydro-electric power station at the base of the middle dome, since a considerable amount of power can be produced without affecting the normal distribution of the water for irrigation purposes. The additional cost of this station will be small, and as a good market for current is available, the revenue or profit from power development will reduce the operating and maintenance expenses borne by the users of water for irrigation.

In the original investigations, alternative designs were made for gravity, single-arch, multiple-arch, multiple-dome, and rock-fill types. Comparative estimates showed that the multiple-dome design was the cheapest and required the least material, except that the multiple-arch design required about 30 per cent. less material, but its cost was still somewhat higher than that of the multiple-dome design. As between these two designs, the multiple-dome was found to give a considerably heavier structure with similar unit stresses. In turn, this heavier structure would give a more uniform quality of concrete and a better protection for the reinforcing steel than would be obtained in the thinner sections of the multiple-arch dam. With the reservoir full and the domes carrying the load, their shape eliminates vertical cantilever action, thus also eliminating tension stresses. With the reservoir empty, the inclination of the domes and the weight of concrete tend to eliminate tension stresses brought about by temperature changes and shrinkage.

As to the piers or buttresses, they are massive and stable, with thickness increasing downwards to the foundation. Their upstream faces slope to meet the shortening radius of the domes, and their downstream faces are sloped to secure a satisfactory overturning factor and reduce the load on the foundation. These piers are so shaped as practically to eliminate tension stresses due to load and to allow only reasonable compression and shear.

This new multiple-dome design was developed under the direction of Major C. R. Olbert, Assistant Chief Engineer of the United States Indian Bureau, in the Department of the Interior, and after the design for the Coolidge Dam had been approved by a board of consulting engineers, it was approved by the Secretary of the Interior in May, 1926. In a description of this interesting structure by Major Olberg in the American *Engineering News-Record*, he discusses the design as follows:—

"The design of the domes is not so complex as might be imagined nor is it difficult to avoid tension and keep compressive stresses within reasonable limits. For any desired unit-stress limit, and using the elastic arch theory, a series of reinforced concrete arches is designed to carry the water load, which varies, of course, with depth. By varying the ratio of rise to span of the arches, there is ample range for a practical design to fit each case. For purposes of calculation each dome is considered as being composed of a series of independent arches normal to the spring line, no account being taken of the strengthening effect of the dome. As the depth increases, the arch is thickened and the radius of curvature and span are shortened. The calculations can be made, therefore, with as much precision as for a concrete arch bridge.

"The extrados is a surface of revolution generated by rotation around an inclined axis, and through an arc varying from 180 deg. at the base to about 80 deg. at the crest. The intrados is not a surface of revolution, because of the thickening of the arch elements at the abutments, but is composed of a series of intradosal curves on three-centred arches. The outer surface at the top and the inner surface at the base are portions of true spherical domes.

"Stresses in the domes due to hydraulic thrust, temperature variations and dead load are all in compression, except for a small area near the base, where the most unfavourable loading—at the Coolidge Dam—produces a tension of about 40 lb. per square inch. The maximum compressive strength in the domes will be about 586 lb. per square inch, and in the buttresses 400 lb. Pressure on the buttress foundations will reach a maximum of 20 tons per square foot. There is extensive use of reinforcing in the domes for preventing temperature shrinkage cracks, anchoring the concrete to the foundation, and transferring shear to the buttresses as the domes approach the crest. Although the crest of each dome is cast monolithic with the arch ribs of the highway bridge, the latter was figured as a separate structure, and is reinforced simply for roadway stresses. It is not expected to carry any thrust from the crest of the dome.

"Reinforcing was put in the buttresses in horizontal layers, 28ft. apart. Because of the large size of the buttresses and the probability that there would be some tendency to crack, two contraction joints were put in along the lines of principal stress in each buttress. These joints extend from a point near the spring line of the dome arches down to the foundation. Across and above their upper ends, ample steel was used to prevent any extension of buttress cracks into the domes. During construction, as the pouring neared the upper limits of these joints, and before the steel tie above them had become effective, there was observed a very slight movement in one of the joints. The sliding factor of the dam, with reservoir full, is 0·73, without uplift. With 50 per cent. uplift at the heel, diminishing to zero at the toe of the buttresses, it is 0·76. With the reservoir full, the overturning factor is 2·83 without uplift and 2·0 with uplift."

VIEW OF DAM IN THE EARLY STAGES OF CONSTRUCTION

This dam was built by the Atkinson, Kier Brothers and Spicer Company, contractors. Work was begun in 1927 and was completed during the autumn of

1928. For the construction of the dam, concrete was made in a pair of concrete mixers of 2 cubic yards capacity each, placed on one side of the canyon at about the elevation of the spillway. They discharged alternately into an inclined trough or chute leading to the base of a steel hoisting tower on the downstream side at the middle of the dam. A 2-yard bucket in this tower raised the concrete and discharged it into a hopper at suitable elevations and served two lines of chutes or spouting suspended from cables and having an inclination giving a drop of 1ft. in 2ft. to 3ft. of length. Revolving lengths of chutes at the ends of the fixed chutes served to distribute the concrete over the entire area of the work. The pouring of concrete averaged 1100 cubic yards per day, with a maximum of 1500 yards, working two shifts of eight hours each. The total amount of concrete in the dam and spillway is about 200,000 cubic yards. In the domes, the thickness of concrete ranges from about 4ft. at the crown to 21ft. at the base.

The proportioning of the concrete, which is given below, was equivalent to about 1 part of cement to 3 parts of sand and 7 parts of crushed stone, including some blocks or pudding stones of 7in. size, which was the largest allowed. This proportioning gave about one barrel of cement per cubic yard of concrete in the domes, and 0·9 barrel per cubic yard in the buttresses. With a water cement ratio of 0·9 to 1·1, the maximum drop or slump allowable in the slump test was 5in. Two classes of mixture were specified, as follows, but these were modified from time to time as conditions changed.

	In domes.	In buttresses.
Cement	1·0	1·0
Sand	2·7	3·1
Stone, ¾ in. to 2½in.	3·1	3·7
Stone, 2½in. to 7in.	2·8	3·2
Strength in 28 days, required, lb.	2200	1800
Strength in 28 days, by test, lb.	2922	2552

In view of the peculiar and constantly changing shape of the domes, it might appear that there would be considerable difficulty and complication with the forms or shuttering, involving expense and loss of time in shifting and adjusting the shuttering as the concrete advanced upward. This proved not to be the case, however, for the contractor, after careful study of the problem, devised a system of adjustable or flexible wood frames or panels that could be used several times. These panels were about 4ft. by 8ft., and had the frames covered with 1in. planking. By means of saw cuts in the frame timbers and the easy bending of the plank covering, the surface of the panel was so flexible that it could be adjusted readily to the varying curvature or double warp of the domes. The adjustments were made exact by measurement from numerous points set by a transit instrument.

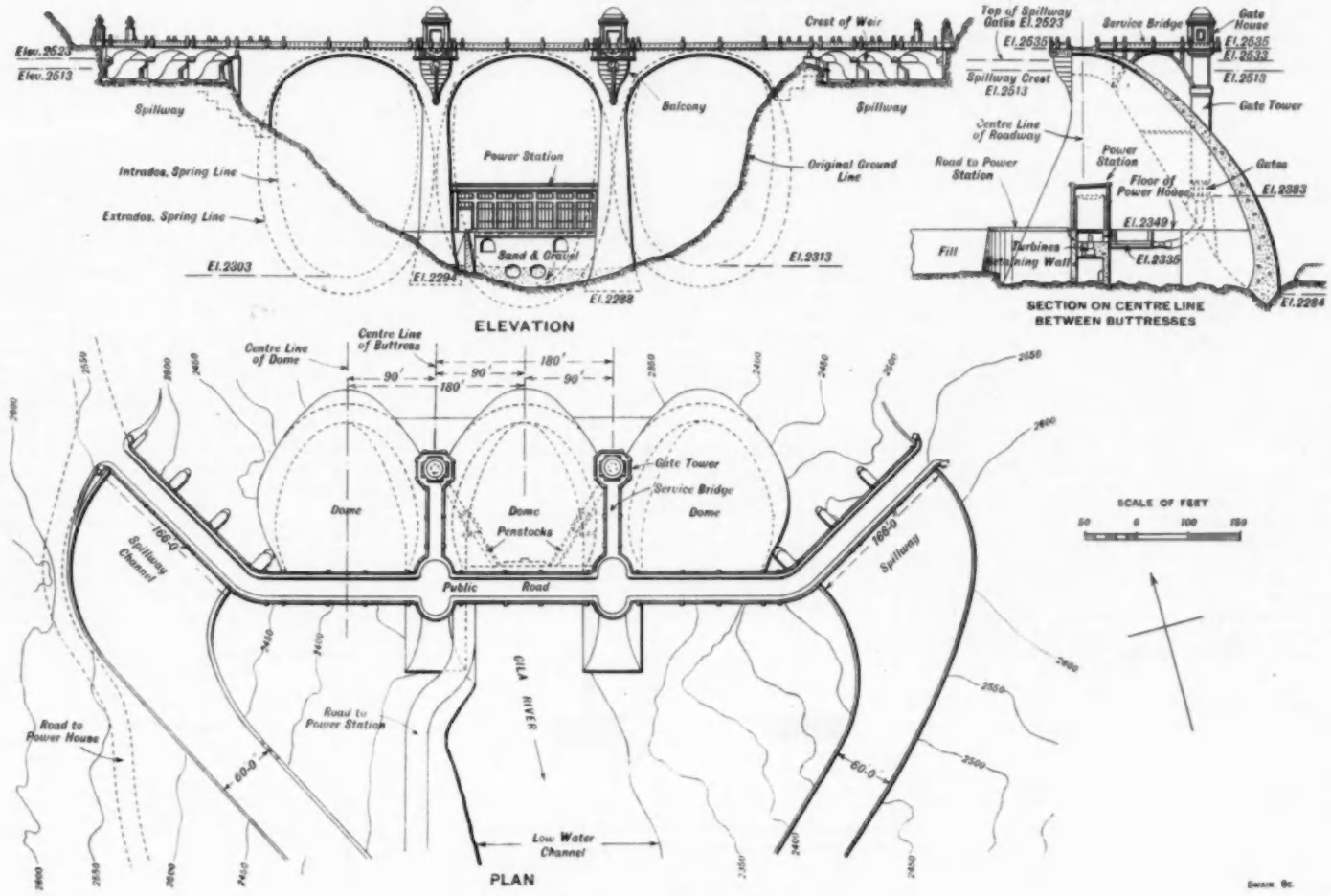
On the inner face of the dome, the panels were held in place by wires attached to anchors embedded in the concrete and projecting from the surface of each pouring. These anchors consisted of rods bent to form an inverted V.

For the top of each dome, beginning about 20ft. below the crest, the shuttering was supported by a series of twenty-two timber trusses, 3ft. to 5ft. apart, placed at right angles to the centre line of the dam. These trusses, of which the middle ones were about 55ft. long, had their lower ends seated on rods or lugs projecting from the face of the concrete already placed. Their upper ends were seated on the upper boom of one of the steel arch ribs carrying the shuttering for the concrete arch of the highway bridge. To enable the trusses to remain in position for a sufficient time, these upper ends fitted into U-bolts which were embedded in the concrete of the arch. On these bolts were threaded sleeves, so that when the concrete of the arch had set, these sleeve nuts could be screwed up sufficiently to transfer the load of each truss from the steel rib to the U bolt and the concrete arch.

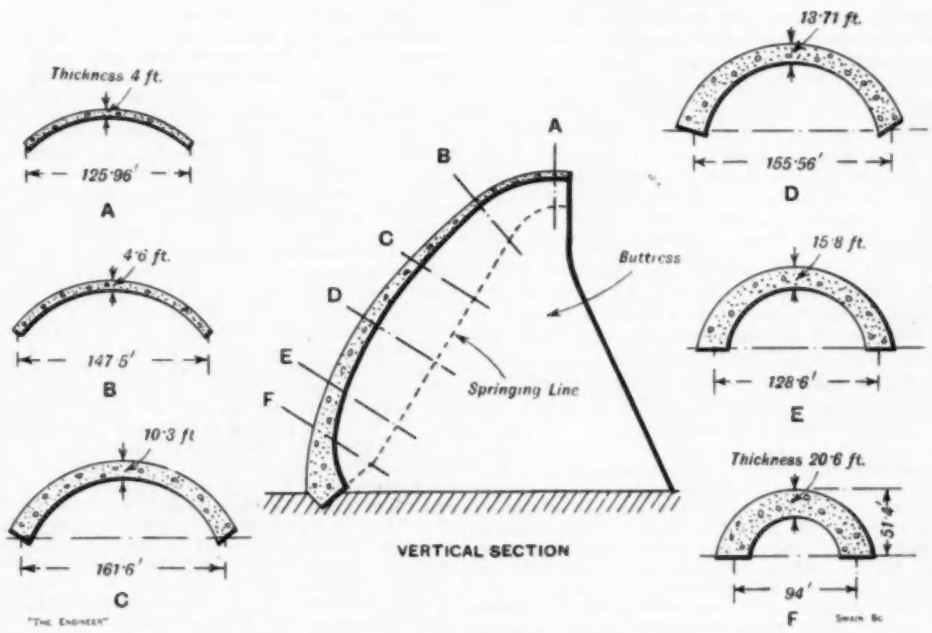
The final step in the completion of the dam was to apply a coating of gunite or stiff cement grout over the upstream surface of the domes, to prevent any leakage, and to give a smooth finish. This was done by compressed air. A layer of wire netting was first spread and secured in place. Then the grout was discharged from the pneumatic "cement-gun" through a line of rubber hose, ending in a nozzle held by a man and pointed downwards. Owing to the insecure footing on the dome, the man was supported by a rope sling, and had both hands free to manipulate the nozzle.

Within the base of the middle dome will be the power station for a hydro-electric plant developing 10,000 kilowatts. The penstocks and controlling gates are arranged in and operated from two towers on the upstream side of the dam. These are in line with the buttresses, and each has a service bridge carried by an arch and connecting with the main highway across the dam.

Both the design and erection of this large dam—of unique type—were under the direct charge of Major Olberg, as Assistant Chief Engineer of the United States Indian Bureau. In the description prepared



ELEVATION, PLAN AND SECTION OF DAM



SECTIONS OF DOMES OF DAM AT VARIOUS LEVELS

by him and quoted above, he gives credit to the following engineers associated with him :—Mr. H. C. Neuffer, designing engineer ; Mr. J. A. Fraps, assistant designing engineer ; Mr. C. H. Southworth, construction engineer ; and Mr. E. L. Ross, electrical engineer. Mr. Fred A. Noetzli was consulting engineer, and Mr. Noetzli and Mr. L. C. Hill constituted a board of engineers appointed to pass on the plans. A second advisory board was composed of General W. C. Langfitt, United States Army, and Mr. A. J. Wiley. It was on the joint recommendation of these two boards that the multiple-dome type specially designed was adopted for the Coolidge Dam.

In conclusion, it may be explained that in the design of the domes they were calculated as a series of unit arch sections, each arch section being determined for the load it would have to support. The method employed was based on the elastic theory, and is given in the book on "Reinforced Concrete Construction," by George A. Hool—Graham Hill and Co., London. The stress in the buttress was calculated by the parallelogram method, including the effect of the shape of the base. The computations were checked by a modification of "Cain's Method," whereby the intensity and direction of the principal stresses were determined. The elastic theory is also the basis of Cain's method.

An advantage of the new multiple-dome type is the facility with which it lends itself to design. Owing to the many variables, the maximum stress can be fixed at any resonable amount, and the dam designed with that end in view. For example, in this case, the maximum combination of compressive stresses in the domes was fixed at 600 lb. per square inch, and the design succeeded in getting 568 lb. In the buttresses, the compressive strength was placed at 400 lb. per square inch, and the actual design gave 396 lb. There is no tension in the buttresses, and in the dome unloaded the maximum tension is 140 lb., which occurs at the base of the dam, and is due to temperature. Under load, the maximum tension in the domes is 40 lb. Since the base of the dam is now submerged and will never be exposed, it is probable that the maximum tension will never occur. To provide for tension and also for shrinkage stress, the domes are amply reinforced with steel bars, placed 6in. from the surface on both the interior and exterior faces. The back of the dam is faced with a coating of "gunite," 1½in. thick, as a further protection for the steel.

In its appearance, the dam is an unusually handsome structure, while it is considered to be more economic and quite as stable as dams of other and older types.

On Retardation and Prevention of Oxidation.

By JOHN G. A. RHODIN, F.I.C.

No. I.

IN the "Chemistry and Industry" Transactions of the Society of Chemical Industry for August 10th and 17th, there appeared a Messel Memorial contribution by Monsieur Charles Moureau and Monsieur Charles Dufraisse, two eminent French professors, on "The Negative Catalysis of Auto-oxidation or Anti-oxygenic Activity." This somewhat strange title covers a subject which is of an absorbing interest to engineers, in the first instance, and to the whole of mankind as the beneficiary in the second. It concerns nothing less than depriving the oxygen of the air of its destructive function, and, secondly, in the modifying of violent, explosive oxidation processes for useful purposes. Negative catalysis might be replaced by the more widely understood expression paralysis, especially as the action of a paralysing poison is a case in point, and, furthermore, these French investigations deal with effects of great magnitude caused by minute quantities of a third extraneous substance, which they treat theoretically in a tentative manner, only to find that negative catalysis is positive.

Catalysis in chemistry means straight or direct action, which may be a combination or a decomposition, caused by the presence of a "catalyser," which acts out of proportion to its chemical equivalency, though within certain limits in proportion to its mass. Combinations by catalysis are much to the front to-day, like, for instance, hydrogenation of oils into solid fats by means of metallic catalysers. Decomposition by this means is not so commonly known, but it is quite an ordinary phenomenon. If you make sulphate of lead red-hot it remains stable, but if you add a minute quantity of iron filings, you can decompose it completely into lead oxide and sulphur trioxide by heating in air, &c. This class of catalysis is easily explained, whereas the mechanism of the previous case is more obscure, though it is probably very similar.

Now, the commonest of all catalysers is water, which is necessary for practically all chemical reactions within a very wide range of temperatures. Without water iron will not rust, carbon will not burn, chlorine will not combine with ammonia, &c. &c. Messieurs Moureau and Dufresse cite some of the well-known experiments of Baker, Dixon and others in this direction, but they do not appear to have considered the probability that their own explanation of the inhibition of catalysis is closely connected with the actual presence of moisture. To this I shall return after having briefly described the essentials of these investigators' publication. They start by reiterating the unique position of oxygen in Nature as being the only strongly chemically active elementary substance occurring in considerable quantity. The consequence is that oxidation processes are very common in this world, and a great number of them are auto-oxidation phenomena influenced by catalysers. To my unsophisticated mind, this undoubted fact proves that there are just as many substances with an affinity for oxygen as there are processes of this kind going on, and as the oxygen contents of the air do not vary appreciably in a century, we must take it that there are just as effective processes at work setting the oxygen free again, or—and that is the rub—that all these processes have effects infinitesimally small compared with the sum total of atmospheric oxygen. There is probably an excess of fixation of oxygen, but geologically this is of very

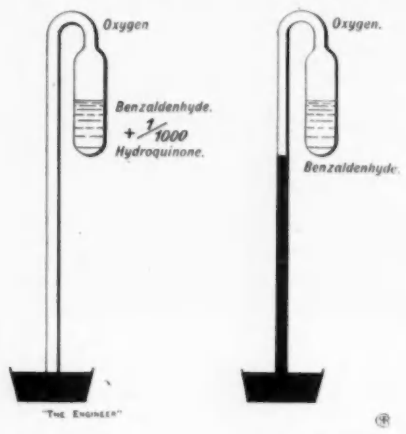


FIG. 1

FIG. 2

small consequence indeed, whereas to mankind the auto-oxidation of metals alone may, in time, make industry such as we know it impossible by spreading the metallic oxides about enough to make collection impossible. If Messieurs Moureau and Dufresse wanted an apology for the study of anti-oxygenic action, this seems to me to be the one *par excellence*. The historical details of the struggle of mankind in combating the destructive effects of oxidation given by these authors are somewhat meagre, but we might agree with them that "anti-oxygenic activity has been a mystery," not only "up to the last few years," but maybe remains one to this day. How they attempt to throw light on the subject is shortly as follows.

To begin with, they constructed an experimental apparatus similar to the one used for measuring vapour pressure on the barometric tube principle. The top of the tube is, however, bent round, and expanded into a test tube in which various liquids can be exposed to an atmosphere of oxygen, and the variation of pressure is measured by the rise of the mercury in the vertical tube—Figs. 1 and 2. In this class of apparatus these authors have studied the effect of innumerable substances upon the oxidation of easily oxidisable compounds of which they give benzaldehyde as a typical example. An addition of 0·1 per cent. of hydroquinone prevents the rise of the mercury by the normal absorption of oxygen. Curves, illustrating the variations with the percentage of hydroquinone added, are given in Fig. 3. Benzaldehyde is given as an example of true combination with oxygen, as this substance converts itself into benzoic acid when exposed to the air, as, being an aromatic or cyclic aldehyde, it has no tendency to polymerise, like the aldehydes of the fatty or aliphatic series. Now the curious fact is that hydroquinone prevents such polymerisation, as the authors show in the case of acroleine, which I might explain is an aldehyde formed by depriving glycerine of water, and which gives the characteristic smell to burning fat. They have replaced hydroquinone with a whole series of easily oxidisable substances, including sulphur, phosphorus and certain metals ; in fact, they have varied both participants in the reaction in a great many ways, and they have found that the same substance may inhibit oxidation of one and promote that of another form of oxidisable matter. Their mode of expressing things is rather slipshod, as they put oxidation and polymerisation as equivalent, as, for instance : "Iodine, a strong anti-oxygenic catalyst towards benzaldehyde is pro-oxygen towards styrene." (Styrene does absorb a small amount of oxygen, like acroleine, but then it polymerises into a solid, being itself a polymerisation product of acetylene.) Furthermore, such a reversal of anti-oxygen to pro-oxygen can occur with the same substance, *e.g.*, a solution of sodium sulphite in water, if the reaction changes from acid to basic, &c.

Taken all round, this method of ascertaining the probable practical effect of certain small additions to various liquids with regard to their behaviour towards oxygen is simple and convenient, and it is a pity that it has not been applied to the behaviour of finely divided metals, moistened with solutions of hydroquinone and of other soluble substances amongst the many considered in the other direction. The authors did, however, limit their scope to "unsaturated hydrocarbons, aldehydes, delicate perfumes, rubber, fats, oils, and so on," as they say in the section on practical applications. Anyway, they jump from these experiments to a tentative theory, which is too much akin to metaphysics to have any connection with the actual experiments.

They postulate that the catalytic oxidation processes are irreversible in the cases in question, *e.g.*, that benzaldehyde cannot be regenerated + free oxygen from the benzoic acid formed, &c. A second postulate is that the catalyst acts in a positive sense in all cases, but gives rise to peroxides of both catalyst and the "active" molecules of the oxidisable substance, which peroxides destroy each other and revert to the *status quo ante* in cases of "anti-oxygenic catalysis." In this way the "active" molecules are kept busy with those of the catalyst in a cyclic process, which achieves nothing as long as the two hypothetical peroxides balance each other. If one or the other is formed in excess the action is either negative or positive catalysis. In this way the theory will adapt itself to any observed facts, but its metaphysical nature is obvious from the following remark by the authors on page 827 of the issue of August 10th of the cited publication (second column, third paragraph) :—"Whilst in our experiments the concentration of the primary peroxide has never attained the order of that of the activated molecules (*i.e.*, extremely small), in the experiments of Gaffron, where the activation is produced by the application of external energy (light), the concentration attains a value at which the properties of the peroxides may be examined. In particular, we are interested in the possibility of catalytic dissociation, which is predicted by our theory." Now, "catalytic dissociation" is a guarded expression like "activation," which is borrowed from Arrhenius' first publication on electrolytic dissociation. The reason is probably that the authors treat electrolytes and dielectrics together, and do not feel justified in assuming that a dielectric can be ionised, but may be capable of forming "active" molecules which I presume they consider electrically charged. How catalytic dissociation can be equivalent to the well-known action of light in producing organic peroxides is left to the reader's imagination. I take it that practically all catalytic phenomena are associated with the presence of hydrogen ions, and that all hydrogen compounds are more or less dissociated into partly such ions.

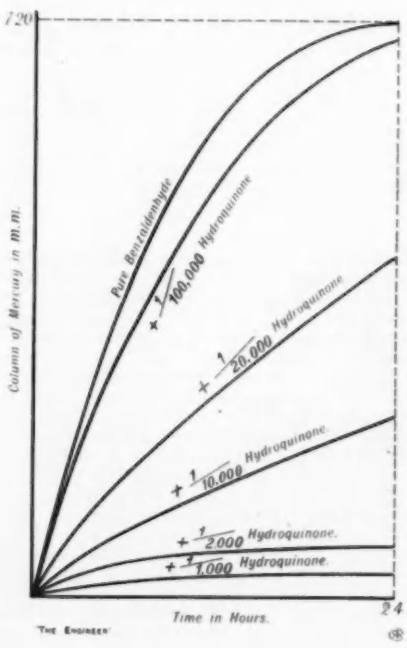


FIG. 3

Dixon found many years ago that hydrogen compounds will restore reactivity to thoroughly dried gaseous mixtures in the same way as water, and Hughes confirmed this with respect to ethyl alcohol. We must further ascribe the influence of metallic catalysers on hydrogen to the ionising by imparting of electric charges and so on. In the case of dielectrics we can assume that the inverse value of the incubation resistance is proportional to the ionisation and the conductance electrolytic. This return to Berzelius' dualistic theory with regard to dielectric hydrogen compounds has a great deal of plausibility, if we consider the chemistry of the cyclic hydrocarbons, which concerns the reactivity of the hydrogen atoms

only. If benzol is acted upon by chlorine, hydrochloric acid is formed as the main exo-thermic reaction and the addition of chlorine to the benzol-rest is accompanied by a smaller dissipation of energy. Even a heated mixture of sulphuric and chromic acid only oxidises two hydrogen atoms of anthracene giving anthraquinone, &c. An example might be given with practical bearing upon the subject under discussion, viz., chloroform. This substance was one of the supporting pillars of the type theory as opposed to the dualistic Berzelian, but if pure it readily decomposes in the air and light, yielding free chlorine, hydrochloric acid and phosgene gas. If a percentage of alcohol up to 1 per cent. is left in the preparation, it keeps practically unaltered. In this case one chlorine atom and a hydrogen one are partially ionised with a tendency to oxidise, and this is prevented by a small percentage of alcohol acting as an anti-oxygenic catalyser. Messieurs Moureau and Dufraisse have thus on consideration no need for any particular catalytic dissociation as an adjunct to their peroxide theory. Whether this theory has any permanent validity or not, these gentlemen have all the same shown experimentally that a great and varied number of substances occurring as impurities affect the tendency of other substances to oxidise either favourably or the reverse, and maybe that the incredible magnitude of the actions depends upon the reactivity being confined to a small quantity of dissociated atoms, or molecules or particles, if they prefer that expression. The general characteristic of that class of catalyst is in this case a strong tendency to oxidise. By far the most important part of the Messel contribution is the experimental method, which is so simple and direct that it should lead to almost universal efforts to solve the most important practical problems involved.

If we now turn to these practical problems it seems that these investigators have taken very little interest in the most important of them all, viz., the prevention of rusting of iron. They only mention casually that this can "be prevented by covering them (the iron objects) with a thin coating of paint." Unfortunately, this remedy is far from permanent, and hence very costly in the long run. Then there is galvanising or coating with zinc, the effect of which is far more lasting than that the ordinary electrolytic theory would lead one to expect. Undoubtedly the original idea was that the more electropositive zinc would be attacked by preference, if the iron were exposed anywhere. As a matter of fact the reverse occurs, and once the iron is exposed it perishes at a very quick rate. Furthermore, the more electro-positive zinc resists the atmosphere vastly better than mild steel under any circumstances, and quite often better than wrought iron. I am now talking of commercial zinc, containing a modicum of lead, as pure zinc resists corrosion of almost any kind with an astonishing tenacity. Many theories have been advanced, such as a continuous film of hydrogen, a form of grey "oxide" forming an impervious film, &c. These films have a great advantage to speculative investigators, as their presence is as difficult to prove as their absence. We might even suppose that some impurity of anti-oxygenic catalytic nature is the cause. When, however, the zinc starts forming carbonate on the iron, it perishes alarmingly quickly. For this reason wise men prefer to give a galvanised iron roof a coat of paint at once, as the paint sticks to the zinc surface better and adheres to it longer than to iron, which means economy in the long run. Another form of coating for iron is electro-plating with chromium or cadmium. Both metals give highly resistive coatings, but there has not as yet been sufficient time for any trial of permanency in the true sense. Iron has, however, a property of occasionally coating itself with a skin of black oxide, which is as everlasting as anything in this world. What is more, this film reforms itself, if by any chance a strong acid should penetrate and give rise to red rust in the affected part.

From natural reasons all the Nestors amongst the specimens which have stood the test of centuries were made from charcoal iron and steel, by the old processes, but I have fairly old specimens of crucible steel, Martin and Bessemer steel, at my disposal which all look like ebony and appear unchangeable. A process which would induce iron and steel to oblige in this direction at will and without fail would simply be invaluable to mankind. I have been obsessed with this idea for years, and I have collected facts connected with the phenomenon, of which I shall enumerate a few. To begin with, the action is probably not electrolytic in the ordinary sense, as it is almost unthinkable that the traces of iron salts would oxidise to only halfway between the monoxidic and trioxidic state in the atmosphere. Secondly, it is almost certain that the mechanism is the reduction of water in the gaseous state at a very slow rate. There is the well-known fact of the coating of an iron tube with a hard oxide incrustation, when steam is passed through at red heat. This coating approximates magnetic oxide in composition. The rate of formation decreases with temperature at a very quick rate, but there is no reason to suppose that it ceases altogether at ordinary temperatures. If you prepare magnetic oxide by decomposition of steam and dissolve it in hydrochloric acid and pour this solution (not *vice versa*) in an excess of ammonia, you get a black, granular precipitate, which becomes magnetic on drying. This peculiar fact shows, apparently, that the magnetic oxide keeps its nature in solution, and also that it may be formed by pouring a solution of equivalent proportions of the chlorides into ammonia. Continuing, these adhesive coatings of black oxide appear mostly on pure hammered wrought iron and steel; on ordinary qualities they are not protective and permanent, and on rolled material less so than on hammered stuff. Dust falling on a bright surface of pure wrought iron promotes ordinary red rust, whilst the under side of the same piece remains bright and eventually turns black. With pure iron an originally red coating of rust often turns black, especially if handled. Alkali promotes black rusting very often, even in the case of cast iron. I have got a so-called copper of cast iron which has been used for boiling with soapsuds for years and is now coated with shiny black oxide and never rusts with little or no care. The case is the same with tools for working Portland cement. For that matter the remarkable lasting power of ferro-concrete is a case in point. This points to the probability that hydroxyl ions may predispose to the formation of the black oxide and bring us back to Cushman's researches. Reviewing these observed facts the direction of research would be:—

Steam Effects.—(1) Exposing iron and steel specimens to steam with short temperature increments between 100 deg. Cent. and, say, 600 deg. Cent.

(2) Exposing similar specimens to water vapour, with or without oxygen, at temperatures below 100 deg. Cent.

(*a*) Without additions.

(*b*) With the specimens coated with thin layers of sodium peroxide or other similar peroxides.

(*c*) With mixed vapours containing:

(1) Reducing compounds like alcohol, ether, hydrocarbons, &c. &c.

(2) Vapours of unstable nature, like benzoldehyde, chloroform, &c. &c., which easily give rise to acids by oxidation.

All these experiments may be carried out in an

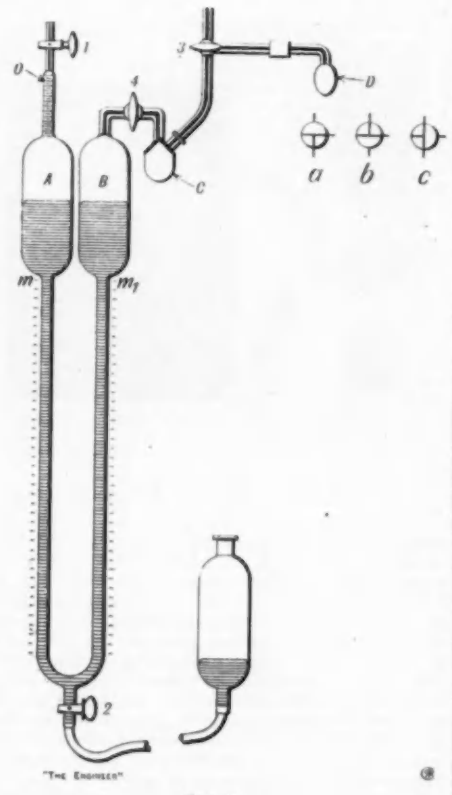


FIG. 4

apparatus of the kind proposed by Messieurs Moureau and Dufraisse, allowing the observation of alteration of pressure, when working with unsaturated vapours. In order to make myself fully clear I give in Fig. 4 a sketch of the apparatus such as it would be to serve these purposes, whilst allowing easy manipulation. The apparatus must be a closed one, because, when examining the effect of vapours without air or oxygen the acting pressures are low at low temperatures. I have, hence, designed the apparatus to work against a vitiated vacuum, the pressure of which can be regulated at will. The principle is well known, having been used by Lunge and Hempel for ordinary gas analytical purposes. The cylindrical vessel A is continued upwards by a small graduated part allowing accurate mensuration of small volumes of air. Its volume between the mark *m* and the joint to the capillary at *o* may conveniently be 50 cm³. A capillary tap 1 is provided at the top. A continues downwards as a graduated barometric tube of as small a bore as practicable, say, a 2 mm. capillary which forms a T joint with the tap 2 to bend upwards into another barometric tube which expands at the top into a second cylindrical vessel B, which again is connected by a capillary with the small reaction vessel C. This is provided with a side tubulure in which the glass stopper of the capillary three-way tap 3 is fitted. The bottom tap 2 is connected with a levelling vessel by means of pressure rubber tubing. The volumes of B and C should be equal to that of A. All the ground joints should be safe against vacuum. In order to be able to compute the area of the metal acted upon easily it is best to draw the specimens into wire of the same diameter and to use equal lengths rolled up into small spirals, which are introduced into the reaction vessel C through the tubulure. The whole of the apparatus should be enclosed in a water thermostat with glass front and back through the bottom of which the tap 2 protrudes to allow the manipulation of the levelling vessel. Mercury is naturally used as the filling fluid. The liquid to be vaporised is put in small capsules D, which can be connected with the three-way tap 3 as shown. All specimens should be chemically cleaned before starting.

Specimen Experiment.—It is decided to investigate the influence of water vapour free from air at 30 deg. Cent. At this temperature the pressure of saturated water vapour is 31·5 mm. mercury, and the weight of 50 cm³. vapour is 0·1505 grammes. The barometric pressure is, say, 780 mm. To avoid condensation, working under 25 mm. pressure is decided upon. With the specimen in C the mercury is adjusted approximately as shown in Fig. 4, with taps 1, 2 and 4 open and 3 in position C. Tap 4 is then closed and the levelling vessel is raised further till the mercury reaches tap 1, which is then closed. Tap 3 is then turned to position *b* and the water is boiled in D to expel air, and, whilst hot, 3 is turned to position *c*. An efficient vacuum pump is then connected to the projecting capillary and set going, tap 4 is opened and closed as the mercury reaches it, the evacuation being continued till a good vacuum is obtained in C, when tap 3 is turned into position *a*, and the temperature of the whole apparatus is adjusted to 30 deg. Cent. apart from D, which is kept cold. By manipulating the levelling vessel and tap 1 a volume of air at atmospheric pressure of 1·6 cm³.* is allowed to enter A, after which the levelling vessel is lowered enough to open 4, observing the mercury fall in B. The starting point for the experiment is obtained by adjusting the mercury level in A to the mark *m*, when 2 is closed and 3 is put in an intermediary position between *a* and *c*. The level in B should be close to *m*, and can be adjusted exactly by manipulating taps 3 and 2 and heating or cooling D, as any physicist will know how. When levels *m* and m_1 are adjusted the apparatus is left at constant temperature and the levels *m* and m_1 are observed periodically.

The query is, Will the meniscus at *m* fall, rise or remain stationary? If there is an oxidation of iron by water vapour without a catalyst at ordinary temperature, the hydrogen formed has just the same volume as the water vapour, and the meniscus should remain stationary, but iron would, under these conditions, occlude or adsorb probably the whole, thus causing a more or less rapid fall of the meniscus. Should the meniscus remain stationary permanently, the absence of a chemical action might be concluded. I may say that the apparatus in Fig. 4, which extends the scope of that of Messieurs Moureau and Dufraisse, can be made incredibly sensitive by further complication and applying the index principle of Otto Petterson and adjustment of the volume of A by a column of mercury in a fine capillary inside the cylindrical part, actuated on the principle of Sondén by a micrometer screw. Probably the establishment of the existence or the reverse of an interaction between pure water vapour and metallic iron at temperatures like 30 deg. Cent. will require all the refinement of apparatus possible, even to the most advanced technique of to-day, as the formation of even the faintest coloured film on polished pure iron in pure air takes months. I cannot in this article go more deeply into the subtleties of the action without a catalyst; with many the apparatus in Fig. 4 should be sufficiently sensitive. So far action by steam.

B. *Possible Formation of Black Films by Chemical Action.*—With regard to this, makers of gun barrels have for a very long time employed some kind of "browning" process, which leaves the surface of the barrels coated with a brown oxide film of a fairly protective nature, approximating that of the natural black oxide. One method consists in rubbing the cleaned iron surfaces with antimony butter—antimony trichloride, $SbCl_3$—mixed with olive oil. The chemical action consists in precipitation of metallic antimony and the formation of ferric chloride, which is partially reduced to ferrous chloride by the iron. This chloride mixture rapidly takes up oxygen through the catalytic action of the Fe-Sb couple, and thus a thin oxide coating is formed, which when washed and dried is exposed to the air for a further period, to be ultimately polished with shellac or the like. Taking the view of Messieurs Moureau and Dufraisse, we have here a case of pro-oxygenic catalysis changing into an anti-oxygenic one. Probably the antimony shortens the time of action, but it is not necessary, as ferric chloride and even nitric acid are employed for the same purpose with good results. Taking ferric chloride, would it be possible to balance the concentration and the time of exposure so that sudden immersion in an excess of ammonia would produce

* 1·6 cm.³ air at 780 mm. pressure expand to 50 cm.³ at 25 mm. pressure.

instantly a decently adhesive black coating? It is certainly worth trying, as this would open the road to something cheap and hence practical.

I mentioned above that slow oxidation in presence of alkali seemed to predispose iron and steel towards the formation of black, protective oxidation. Here some fundamental experiments might be made with heating or even boiling iron objects with mixtures of caustic alkalis and their peroxides in order to ascertain whether black films will form with practical speed. As these peroxides easily decompose with water, the action should be started in the cold. Sodium peroxide is the more stable, and it is of great interest to know, whether sufficient Na_2O_2 will remain in equilibrium at 100 deg. Cent. to act catalytically. Accepting the theory of Messieurs Moureau and Dufraisse, we know that iron forms a higher oxide than the "peroxide" Fe_2O_3, viz., ferric acid, FeO_3, salts of which are fairly easily produced, and it is not "stretching it" too much to imagine that an actual superoxide FeO_3 may exist, momentarily, to perform the circular reaction of these investigators. Supposing the magnetic oxide has the formula $Fe_2O_3 . FeO$ we might conceive of the reversible reaction—

$$Fe_2O_3 . FeO + O \rightleftarrows Fe_2O_3 . FeO . [O] \quad . \quad . \quad (1)$$

in which [O] stands for the charged oxygen atom added to their anti-oxygenic catalysers. The other reversible action would be—

$$\tfrac{1}{2}(Fe + O_2) \rightleftarrows \tfrac{1}{2} Fe\,[O]_2 \quad . \quad . \quad . \quad (2)$$

The products of (1) and (2) meeting causes reversal.

Like the theory cited, this is metaphysics, but it will give a certain resting point to the mind as to the action of these films, as conforming with the views of Messieurs Moureau and Dufraisse. I have written these formula like those of the paper with the square brackets indicating atomic charge. They ought to be—

$$FeO_3 . FeO + O + \Delta E \rightleftarrows Fe_2O_3 . FeO . [O] \quad (3)$$

and—

$$\tfrac{1}{2}(Fe + O_2 + 2\,\Delta E) \rightleftarrows \tfrac{1}{2} Fe\,[O]_2 \quad . \quad (4)$$

This to indicate the energy quantities ΔE which balance in cases, when progressive chemical action is absent.

Here I wish to make the addition that these reactions are unthinkable without water being present, and that the "dry" oxidation films must form in the presence of water vapour as an intermediary for the exchange of the energy quantities. In other words, although not electrolysis in the ordinary sense, catalytic action accompanies ionisation of a hydrogen compound. Furthermore, ΔE in (3) and (4) cannot balance perfectly; there must always be a $\Delta_2 E$ as P.D. in the best case almost infinitesimal, but the action must be progressive one way or the other, or else it cannot exist at all.

I have now brought the matter of a possible application of the theory of Messieurs Moureau and Dufraisse to that all-important problem, the protection of iron against rust, and I have endeavoured to show how their experimental method may be adapted to critical investigations in this line. Addressing practical readers, I have taken the black oxide film as a proven example of perfect protection and indicated some ways in which experiments should be made to find how these films could be produced at will in practice. In the next article I shall enter into the protection of rubber against perishing by oxidation, and anti-knocking compounds. From a purely theoretical point of view, the working hypothesis of the cited authors is unsatisfactory without an external addition of free energy, which starts the catalytic action, the progress of which, if "positive" is generally easy to understand, if exo-thermic like most oxidation processes, which yield the energy to keep the catalysis going. Once started, the action is confined to the charged or dissociated particles, just like electrolysis, and I shall discuss the possibility of extending the ordinary theory of electroysis to embrace this peroxide hypothesis to explain the start.

(To be continued.)

Physical and Optical Societies' Exhibition.

No. II. *(conclusion).**

ON the stand of the M.O. Valve Company, which makes Marconi and Osram valves, something interesting is generally to be found. This year several pieces of apparatus, designed chiefly to demonstrate how the high frequency current generated by valves may be used for widely different purposes, were shown in operation. By means of two large oscillating valves generating high-frequency current, metallic filament lamps were made to light inductively and water was made to boil in the same way by immersing a metallic loop in the liquid. The highly advanced technique of cooled anode valve manufacture was demonstrated by an oscillating circuit with two miniature cooled anode valves in parallel. These two valves were fed with alternating current from the mains through the usual transformers, the anodes being at a potential of approximately 5000 volts R.M.S., and dissipating approximately 400 volts. The valves, which are not of standard construction, are fitted with water jackets and are cooled in a similar way to larger valves. The high-frequency current generated was used to energise four Neon-filled letter lamps, forming "M.O.V. Company." Neon lamps, placed in the vicinity of the exhibit, lit up spontaneously. A machine was shown that makes valve filament supports entirely automatically. Nickel wire from a reel is fed into the machine, which drops the supports cut to the correct length, and with one end flattened and bent over down a chute.

An entirely new range of dull-emitter transmitting and modulating valves was exhibited. These show a considerable advance in performance, coupled with considerable economy in filament consumption. The approximate electrical characteristics of the types are given below:—

	DETI. SW.	DET. 2.	DEM. 3.	DET. 3.
Filament volts	6·0	12·5	15·0	15·0
Filament current	2·0	3·0	4·0	4·0
Amplification	8·5	16·0	5·5	16·0
Impedance	5000	4000	1250	3000
Anode volts	1000 max.			

A demonstration was arranged with a view to showing how the dimming of a rectifying valve filament may lead to serious overheating of the anode, with consequent loss of filament emission. This action is due to the increased impedance of the valve, which gives rise to a larger voltage drop across the rectifier, causing the anode to dissipate a much higher wattage than normal.

This year Ferranti, Ltd., of Hollinwood, were exhibiting electrical instruments of various kinds, including thermal instruments, rectifier instruments for power supply frequencies, ammeters for 132-kV systems, a multi-range test set, a valve tester, and a portable A.C. voltmeter. In the thermal instruments the thermo couples used are in vacuum for the low

FIG. 9—VALVE TESTING SET—FERRANTI

ranges and in air for the higher ranges. The lowest milliampère range is 25, which is also used for voltmeters and the upper range 5 amperes. A long scale (2¼in. on a 2½in. diameter instrument), good damping and accurate workmanship are the outstanding features of these instruments. As the couples are insulated from the heater, there is no capacitence effect of the movement to earth and no reversal error on D.C. The instruments are equally accurate on high frequencies, supply frequencies or direct current. One of the instruments has been in satisfactory operation for some time on a 3-m. wave length. Temperature compensation is good, *i.e.*, less than 0·1 per cent. per degree Centigrade, and the overload capacity is about 50 per cent. momentarily. The moulded insulating cases are particularly suitable for high frequencies. The consumption of these instruments is very small, *i.e.*, for the 25 mA size, about 20 milliwatts.

Rectifier instruments were among the attractions on this firm's stand. The standard Ferranti 2½in. radio instrument movements are combined with Westinghouse copper-oxide rectifiers to produce A.C. instruments, having the following features:—(1) High torque, equal to that of moving coil instruments; (2) efficient damping, equal to that of ordinary moving coil instruments; (3) very small current consumption, which is constant for all ranges; (4) improved scale shape. The ranges are:—0–1, 0–10, and 0–100 volts. The lowest range has a separate scale, but the 10 and 100-volt indications are contained on one scale. Consumption is either 7·5 mA or 1·5 mA and these figures apply to the 1-volt range. In the single range pattern these instruments are available in ranges from 0–1·5 mA to 0–50 mA, and from 0–1 V to 0–250 V. They are correct on all power supply frequencies and wave forms. The instruments are corrected for temperature, the error being very small. This class of instrument is particularly suitable for low voltage and current ranges, and for cases in which a very low volt-ampère consumption is essential. For general laboratory work the milli-ammeters and low-range voltmeters are claimed to be unequalled, combining low consumption with the robustness of switchboard instruments.

The Ferranti instrument shown in Fig. 9 is for testing the valves in a wireless receiving set under working conditions. To do this, the valve to be tested is removed from its socket, a plug which is permanently attached to the instrument is inserted in its place, and the valve is then reinserted on top of the plug. By rotation of the switch knob to the positions marked on it, it is possible, to read, successively and on the same dial, anode volts and current, filament volts, grid bias volts, and continuity of the grid circuit. The ranges are:—Anode volts, 0–100 and 0–300; anode current, 0–10 and 0–100 mA; filament volts, 0–10; grid bias, 0–10 and 0–100 volts. As a voltmeter, the resistance of the instrument is 1000 ohms per volt—*i.e.*, 1 mA full scale current.

Several special features are embodied in a high-grade microphone—see Fig. 10—that was

FIG. 10 MICROPHONE IGRANIC

exhibited by the Igranic Electric Company. It is claimed to respond uniformly to sound waves of all frequencies, and with complete freedom from objectional background noises which so often mar the results obtained from other microphones. It is designed so that the path of the current is at right angles to the plane of the diaphragm, with the result that sound waves impinge on the diaphragm at right angles to the direction of current flow. As it is possible to employ a diaphragm that is a non-conductor and practically non-resonant, the instrument is said to respond evenly to notes of all audible frequencies. The remarkably uniform frequency response of this "Transverse" current microphone is not, however, only due to the use of a non-resonant diaphragm, but to other important constructional details. Several compartments are interspaced between the two electrodes, each containing carbon granules of a size different from those in other

FIG. 11—MICROPHONE CONTROL UNIT—IGRANIC

compartments. Each group of granules responds to one band of frequencies more than another, and the grading of the granules into groups of various sizes ensures that all frequencies are dealt with uniformly, so that the speech or music produced before the microphone may be amplified, and reproduced with clarity and tone balance. The combination of this principle with the use of a non-resonant diaphragm enables results to be obtained that are very satisfactory, whilst the construction also makes it impossible for the microphone to pack whilst it is in operation. The microphone is also exceptionally sensitive and will operate satisfactorily at considerable distances from its associated amplifiers without deterioration of quality of reproduction or diminiution of output intensity. It is claimed to be particularly suitable for broadcasting stations, public address systems, for band repeating work; and, in fact, for all classes of

* No. I. appeared January 11th.

service calling for a high-grade instrument. An advantage of the instrument is that it will operate at voltages ranging from 2 to 20, and if only used intermittently even higher pressures may be employed. The resistance is in the neighbourhood of 500 ohms, and when used with a 6-volt energising battery the current consumption is approximately 12 milliampères. Most types of dry cells are therefore suitable for the purpose. In order to gain the fullest advantage from the high standard of performance of this microphone, it is very necessary that the means of coupling the microphone to the amplifier should be of the highest order, *i.e.*, capable of preserving the true frequency response of the microphone. For this purpose the Igranic Electric Company has developed a special microphone control unit—see Fig. 11—which consists essentially of a transformer having a step-up ratio of 10 : 1, a milliammeter which is connected in the primary circuit of the transformer, and which registers the microphone energising current, and a switch which controls either the microphone or other associated input, *e.g.*, a gramophone electrical pick-up or other similar device. It is therefore possible with the control unit alternately to connect to the amplifier either the microphone or any other sound-producing device, as required.

Everett, Edgcumbe and Co., Ltd., were exhibiting rectifier-operated moving-coil instruments covering the widest possible range of measurements. These instruments consist of a specially adjusted moving-coil system, operated in conjunction with a series of four copper-oxide dry rectifiers, arranged in the form of a Wheatstone bridge, as shown in Fig. 12.

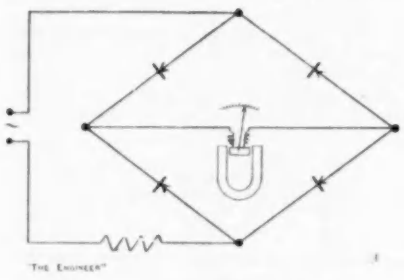


FIG. 12 CONNECTIONS FOR RECTIFIER INSTRUMENT

The instruments are particularly suitable for A.C. measurements of small currents and low voltages, the determination of which has hitherto been almost impossible, except with the use of reflecting laboratory instruments. Almost any desired range can be provided : for example, ammeters are supplied which give a full-scale deflection with any current down to 1 mA and up to 500 mA, or, if used in conjunction with a small current transformer—contained in the case of portable instruments—up to hundreds of ampères.

Voltmeters can be supplied to give full-scale deflection with voltages as low as 1 volt, and there is no upper limit. Voltmeters and ammeters—other than those operated through current transformers—are equally available for use on direct current, should occasion at any time arise. Being of the moving-coil pattern, these ammeters and voltmeters possess the many well-known advantages of such instruments, *i.e.*, dead-beatness, high working forces, constancy of zero, and an almost evenly divided scale throughout the useful range. The rectifier principle is also applicable to low consumption switchboard ammeters for use with bushing transformers, but in view of the low consumption and extreme dead-beatness of the latest pattern of Everett-Edgcumbe moving iron ammeter, the extra expense and complication of a rectified instrument is not often justified.

The many advantages of the bar type of single-turn current transformer as regards reliability has led this firm to devote special attention to its design, and by the use of cores of nickel-iron alloys very great precision has been attained. On the other hand, with the ever-increasing voltages in use in this country—as, for example,132 kV adopted for the new Grid—the currents to be dealt with are extraordinary small, so that the available ampère-turns of such transformers are so much reduced that it is essential to minimise the power consumption of the measuring instruments, relays, &c., connected to the transformer secondaries. To this end, Everett, Edgcumbe have introduced ammeters which consume only ¼ VA at full-scale deflection, relays of all kinds, overload, directional, instantaneous, time lags, &c., also consuming ¼ VA or less. By the use of such instruments, fitted with a ½-ampère current transformer secondary—in place of the usual 5-ampère transformer—it is possible to reduce the total burden on the current transformers to less than 2 VA, even with the very long connecting leads which are so often necessary in modern power stations. In this way, accurate single-turn current transformers are now available for full-load currents of 20 ampères or less. The scale of the ammeters is extremely open at the lower end, so that accurate readings of the high-tension current are possible down to as little as 2 ampères.

An interesting exhibit was a set of springs showing the various stages of manufacture, from the crude wire to the fine strip, and, finally, to the finished springs, accurately coiled, hardened and annealed. Everett, Edgcumbe, we believe, are the only instrument makers in this country who manufacture their own springs, a circumstance which enables them to keep exact control over this most vital part of all measuring instruments. Any departure from the predetermined sequence of heat treatment at once shows itself in a wandering zero, loss of constancy, and other defects. When it is mentioned that the thickness of many of the springs used is well under ·0005in., and that a spring ·0005in. thick exerts more than twice the torque of one ·0004in. thick, it will be realised to what a degree of accuracy it is necessary to work.

A photo-electric micro-photometer, designed to measure the densities of light filters or of photographic plates, was exhibited by the Cambridge Instrument Company. It is of the type originally developed by Dr. G. M. B. Dobson, of the Clarendon Laboratory, Oxford, but incorporates certain modifications suggested by Dr. H. W. B. Skinner, of Bristol University, which make the apparatus more rigid and compact, and at the same time more simple in operation. The main differences in the designs of the two

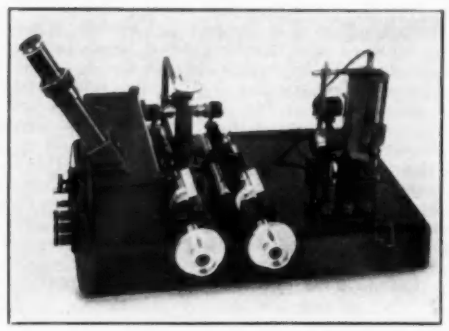


FIG. 13 MICRO-PHOTOMETER—CAMBRIDGE

models are : (*a*) in the latest pattern the optical system is arranged in a horizontal plane, while in the earlier instrument it was in a vertical plane. The plate under test is itself more easily visible and the various adjustments more accessible ; (*b*) the shutter which cuts off the alternative light paths is mounted immediately after the lamp in the earlier pattern while in the latest pattern it is advanced in the optical path to be beyond the plate and wedges. The instrument is capable of taking measurements over an area of 30 mm. by 50 mm. at one setting. The displacement of the spectral lines can be measured by estimation to 0·001 mm.

The apparatus is illustrated in Fig. 13 and the arrangement of the optical system is shown diagrammatically in Fig. 14. Two beams of light from the opposite sides of the straight filament of a gas-filled lamp B—6 volts, 24 watts—are reflected from silvered mirrors M M mounted symmetrically on either side of

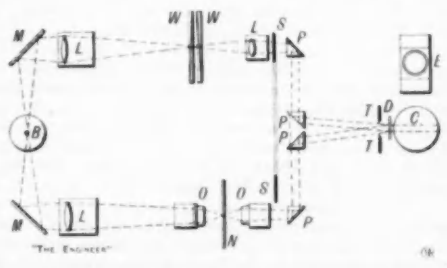


FIG. 14 ARRANGEMENT OF MICRO-PHOTOMETER

the lamp and then pass through different optical systems. One beam of light passes through a condensing lens L and a microscope objective O, which forms an image of the lamp filament on the surface of the photo-electric plate N which is to be tested. A second objective O, identical with the first, and two reflecting prisms P form an image of the transmitted beam in the plane of an adjustable shutter T in a light-tight box containing a photo-electric cell C. The second beam from the lamp passes through a condensing lens identical with that in the path of the first beam, and then through a pair of optical wedges W, a lens, and two reflecting prisms P, which form an image of the filament in the plane of the adjustable shutter and coincident with the image formed by the first beam. The two beams of light are interrupted in turn by a reciprocating shutter S which is operated by hand. The plate under test is carried on a mechanical stage having a micrometer movement of 50 mm. along the plate and a screw movement—calibrated but not micrometric—of 30 mm. across the plate. With the first movement it is possible to reach a point 100 mm. from one edge while with the second movement a point 40 mm. from one edge may be reached. By turning a plate round it is therefore possible to measure a length of 200 mm. in, say, four settings. The optical wedges have a lateral micrometer movement of 40 mm. The standard wedges have a density range of from 0 to 3, and the range may be increased by the addition of further standard absorbing plates. The photo-electric current is measured by means of an alcohol-xylol resistance and a standard Lindemann electrometer—shown at E in the diagram—the deflection of the electrometer needle being viewed through the microscope shown on the left of the engraving. The photo-electric cell is a potassium cell, as originally developed at the Clarendon Laboratory, Oxford. It is highly sensitive and is so constructed as to reduce to a minimum the effects of photo-electric fatigue and of the loss of light by reflection from the window of the cell. The Lindemann electrometer is specially adapted for use with photo-electric cells ; it is compact and robust, has a high sensitivity, and a stable zero. The complete equipment is self-contained except for the batteries providing the current for the lamp and the potentials for the photo-electric cell and the electrometer. The cell requires up to 240 volts and the electrometer 66 volts. The necessary connecting terminals are fitted on the base of the instrument.

The research laboratories of the General Electric Company were demonstrating applications of photo-electric cells, which have been exhibited on previous occasions. Among other things, a self-contained photo-electric set which works entirely from the A.C. mains, was on view. It works a relay and lights up a lamp when the illumination passes the critical value, and in spite of the great variability of the supply voltage the critical value does not change more than 10 per cent. The set is intended for industrial use when automatic control of any mechanism by means of change from light to darkness is required. The method of using the photo-cell is to cause an intermittent current to pass through it when the illumination falls below a certain value. When the illumination rises above that value, the current becomes continuous. The intermittent current is amplified and rectified, and it then operates a relay which can be made to work any desired mechanism in accordance with a change of light falling on the photo cell connected to the set.

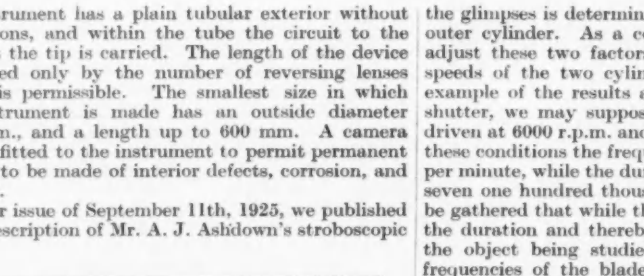
The following applications were being demonstrated : —(*a*) A simple counter registered on a dial the number of interruptions of a beam of light, for example, by the passing of persons or moving objects on a conveyor. A different type of cell can be fitted, which is sensitive to invisible radiation in the infra red, thus allowing the set to be used for such purposes as burglar alarms where a visible light beam would be a disadvantage. (*b*) An arrangement for automatic switching of street lights was shown. In this case, a photo-cell is used in a simple circuit with a valve and relay to switch street lighting on and off at dusk and dawn. (*c*) Automatic control of acid alkali titration with methyl-orange as indicator. The change in the light transmitted by the solution and by a blue filter behind it, stops the supply of standard alkali from a burette when the colour change of the indicator occurs. (*d*) By passing a beam of light through the air in a box and letting the photo-cell view it sideways the set will operate on the introduction of dust particles or smoke into the box. For this purpose a very slow-acting relay has to be used, and one has been specially designed. It consists of a lever just unbalanced about a pivot slightly inclined to the vertical. Its acceleration and therefore its initial velocity is so small that it is held back by the intermittent impulses of current from the set passing through a magnet coil, even when they occur only a few times a second. If the impulses cease, the lever swings slowly round, completes a circuit and rings a bell. The apparatus was designed primarily to indicate any failure in a plant for purifying blast-furnace gas. (*e*) Finally, a photo-electric integrating photometer suitable for measuring the rating of lamps and also for studying their lumen performance on life test was shown. The apparatus is capable of measuring to an accuracy of ± ½ per cent. in lumens, although its accuracy is limited by the degree of steadiness of the lamps which are undergoing test.

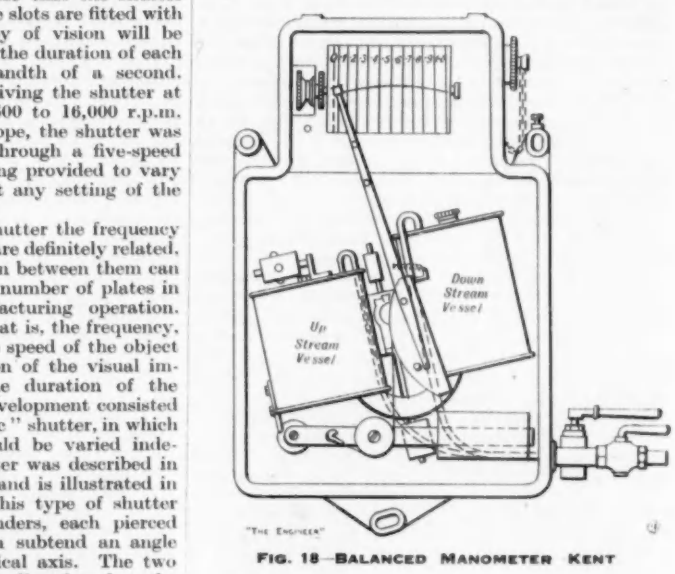
H. W. Sullivan, Ltd., was showing a novel form of wavemeter invented by Dr. N. W. McLachlan, which depends upon a new electrical effect. When the anode voltage of a screened valve is less than that of the screen, the valve has a negative resistance. In the anode circuit a coil and condenser tuned to a radio frequency are connected to a similar arrangement tuned to an audio frequency. With suitably proportioned coils and condensers, a radio frequency modulated by an audio frequency is obtained, and if this modulated C.W. wavemeter is placed near a radio receiver, the audio frequency is reproduced by the loud speaker, provided the receiver circuits are tuned to the wave meter. Thus, a receiver can be tuned without the aid of a transmitting station. Alternatively, if the receiver is tuned to an unknown station its wave length can be found at any time, even when the station is shut down. The wavemeter can also be used as a master oscillator to control or check the wave length of a transmitting station. For check purposes the radio frequency of the meter is held constant by a quartz crystal. A note of the same pitch as the audio circuit is obtained by heterodyning the radio frequencies from the meter and transmitter. If the latter frequency alters, a slow beat will occur between the two audio frequencies, which can be made visible on a meter. By omitting the radio circuit and using a suitable inductance, another new

effect can be secured. A series of interruptions of peculiar wave form occur, and the sound resembles a chirrup. In this case the frequency of the oscillations is imaginary, but the circuit damping is negative. For steady oscillation the frequency is, of course, real and the damping negative.

An interesting device shown by the Foster Instrument Company, of Letchworth, was the "Introscope" an appliance designed to permit the ready inspection for flaws, corrosion, &c., of the interiors of small pipes, barrels and similar deep holes. The instrument resembles the cystoscope used for the examination of interior parts of the human body, in that it consists of an optical system and a shielded source of illumination. It differs from the medical appliance in that the optical system employed gives a wide angle of view of the surface under examination.

A small "Introscope" outfit is illustrated in Fig. 15, while in Fig. 16 diagrammatic longitudinal and cross sections are shown. The surface to be examined is illuminated by light from the lamp L. The light passes out through the aperture A B in the enclosing tube. An image of the illuminated surface is transmitted by a mirror S S to a prism P, whence it is passed through a wide-angle objective O, and so through reversing lenses U U to the eye-piece D. The number of reversing lenses employed depends upon the length of the instrument. In use, the surface being examined appears as if it were being viewed by the eye placed at C. As the rays from the lamp fall on the surface obliquely, minute inequalities are thrown into high relief, and there is no dazzling effect produced in the eye of the observer. The angle of view in the longitudinal direction is wide, and in the circumferential, as shown at E F, is such that rotation of the instrument into three positions can easily be made to cover the whole circumference of the bore. The eye-piece can be made to give various degrees of magnification. Modifications of the design can be made to permit the bottom or return angles of bottle-shaped enclosures to be inspected. Normally the instrument has a plain tubular exterior without projections, and within the tube the circuit to the lamp at the tip is carried. The length of the device is limited only by the number of reversing lenses which is permissible. The smallest size in which the instrument is made has an outside diameter of 6 mm., and a length up to 600 mm. A camera may be fitted to the instrument to permit permanent records to be made of interior defects, corrosion, and so forth.





FIGS. 15 AND 16—THE INTROSCOPE—FOSTER INSTRUMENT COMPANY

In our issue of September 11th, 1925, we published a full description of Mr. A. J. Ashdown's stroboscopic instrument, known as the "Rotoscope." The distinguishing feature of that device was the shutter, by which vision of the moving object under observation was alternately permitted and occulted at a rapid but variable rate. This shutter—shown in the top view in Fig. 17—consisted of a cylinder, about 1in. in diameter and 4in. long, pierced with two rectangular slots, $\frac{3}{8}$in. wide and $1\frac{1}{4}$in. long. Across each slot a number of equally spaced thin plates were placed, the breadth of the plates being equal to the diameter of the shutter cylinder. The number of plates was varied to suit the purpose for which the instrument was required. As an example of the working of this form of shutter, we may suppose that the shutter speed is 6000 r.p.m., and that the slots are fitted with ten plates. Then the frequency of vision will be 12,000 glimpses per minute, and the duration of each glimpse will be one ten-thousandth of a second. Arrangements were made for driving the shutter at different speeds, ranging from 500 to 16,000 r.p.m. As in later forms of the Rotoscope, the shutter was driven by a clockwork motor through a five-speed change gear-box, a governor being provided to vary the motor speed continuously at any setting of the change gears.

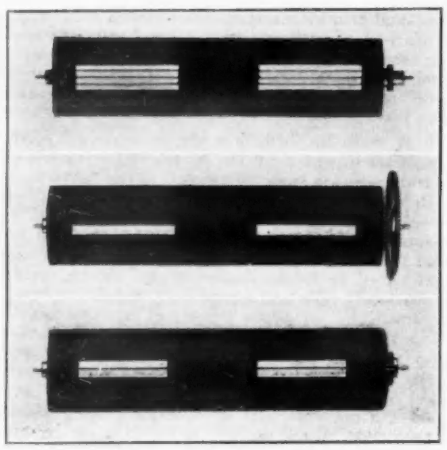


FIG. 17—ROTOSCOPE SHUTTERS—ASHDOWN

In this, the bladed, form of shutter the frequency and the duration of the glimpses are definitely related, and in any given case the relation between them can only be changed by altering the number of plates in the shutter, a delicate manufacturing operation. Since the speed of the shutter, that is, the frequency, has at times to be set to suit the speed of the object observed, and since the definition of the visual impression is dependent upon the duration of the glimpses, Mr. Ashdown's next development consisted of the production of a "heteroptic" shutter, in which the frequency and duration could be varied independently. The heteroptic shutter was described in our issue of January 21st, 1927, and is illustrated in the second view in Fig. 17. This type of shutter consists of two concentric cylinders, each pierced with slots which in cross section subtend an angle of about 20 deg. at the cylindrical axis. The two cylinders are driven in the same direction, but the outer one is rotated much more quickly than the inner—say, nine times as fast. In our article of two years ago, we showed that in the heteroptic shutter the frequency of the glimpses is determined solely by the speed of the inner cylinder, and that the duration of the glimpses is determined solely by the speed of the outer cylinder. As a consequence, it is possible to adjust these two factors separately by varying the speeds of the two cylinders independently. As an example of the results achieved with the heteroptic shutter, we may suppose that the inner cylinder is driven at 6000 r.p.m. and the outer at 54,000. Under these conditions the frequency will be 12,000 glimpses per minute, while the duration of each glimpse will be seven one hundred thousandths of a second. It will be gathered that while the heteroptic shutter reduces the duration and thereby increases the definition of the object being studied, it cannot give the high frequencies of the bladed shutter.

A new form of shutter for the Rotoscope was shown by Mr. Ashdown at the Exhibition last week. This, the "hybrid" shutter, is illustrated in the third view in Fig. 17, and may be described as consisting of a heteroptic shutter with plates fixed across the slots in the inner cylinder. As a compromise between the two earlier forms of shutter, the hybrid type possesses the high definition of the heteroptic pattern and much of the frequency range of the bladed pattern.

The three forms of shutter are not to be regarded as alternatives. Each has its own field. The bladed and heteroptic types can be inserted in the instrument by the user as best suits his purposes. The hybrid shutter cannot, however, be interchanged, except by the makers of the instrument. We learn from Mr. Ashdown that extensive use is now being made of the Rotoscope for a wide variety of purposes, including certain interesting applications in the field of aeronautics, such as in the study of propeller deflection, wing flutter and vibration, and in motor car engineering, for studying, among many other factors, spring surging, torsional deflection and inertial displacement. The instrument, it may be added, is now being supplied by A. J. Ashdown, Ltd., 119, Victoria-street, S.W. 1.

Some manometers, principally intended for measuring low-pressure air or gas flows through pipe lines, were shown by George Kent, Ltd., of Luton. One such instrument was the recording balanced manometer illustrated in Fig. 18. This manometer is designed to deal with an operating head of 2in. of oil at the maximum flow and to record flows down to one-twentieth of the maximum on an equally shaped flow chart. It makes use of two closed pots filled with oil or other liquid, which are attached to a frame suspended on knife edges lying between the pots near their upper ends. The pressures on the two sides of an orifice in the pipe line carrying the flow to be measured are admitted through flexible pipes to the tops of the two pots. Any increase in the difference of pressure causes liquid to be displaced from the left-hand to the right-hand pot, with the result that the right-hand pot becomes overbalanced and tends to sink. The framework to which the pots are attached carries a pen which records the movement of the pots on a chart. If the force returning the pots to the zero position were a simple gravity control, the movement of the pen would be approximately proportional to the head applied to the pots. In order to measure the flow in the pipe line, it is necessary to make the movement of the pen proportional to the square root of the applied head; that is to say, directly proportional to the flow itself. This result is achieved by means of a cam attached to the framework, which carries the pots. A flat band passes from the cam round a circular support to an anchorage on a lever weighted at one end and pivoted to the casing at the other. As the oil vessels turn about the knife edge, the radius at which the pull of the band acts rapidly increases as a result of the shape given to the cam. As a consequence, the flow is recorded on an equal spacing basis. The instrument is fitted with a dust-proof cast iron case, and is suitable for use in steel works and gasworks, at blast-furnaces and cupolas, and generally for measuring low pressure air or gas under most of the conditions met with in practice.

FIG. 18—BALANCED MANOMETER KENT

Crompton Parkinson, Ltd., were showing the "A.C. Test" portable A.C. multirange ammeter- and multi-range voltmeter, with single movement. An example of this instrument was shown for the first time at the Physical and Optical Societies' Exhibition held in 1928, and was described in our issue of January 13th, 1928. The instrument consists essentially of a ring of iron stampings forming a magnet, and having a cylindrical gap in which the movement, constructed somewhat on the lines of an ordinary movement but with specially shaped irons, is fitted. When a conductor carrying current is passed through the ring of iron stampings, they are magnetised and the flux in the gap causes the moving irons to turn and to tend to bridge the gap. The instrument has no windings, and when used as an ammeter it is not electrically connected to the circuit in which the current is to be measured. For current measurements the instrument has an infinite number of ranges in a downward direction from the maximum for which it is scaled, depending only on the number of turns of the current conductor passed through the iron arch. Standard multi-turn attachments are made for instruments scaled from 0–100, enabling them to be used for low current measurements down to a few milliampères and also as voltmeters up

to 600 volts. On any periodicity from 25 to 60 cycles first-grade accuracy is guaranteed, or on higher frequency up to 100, if specially calibrated. The company's "Alltest" D.C. portable multi-range testing set was also exhibited, the set having all its shunts and resistances arranged as separate units, and being suitable for measuring currents from ·00025 ampère upwards and voltages from ·001 to 600. It can be used with any external shunts having 75 mV drop, and its accuracy is within 1 per cent. of maximum reading at all ranges. Among other exhibits there was a standard Crompton potentiometer equipment and a Crompton Robertson bridge potentiometer.

This direction finder, shown in Fig. 19, is of an entirely new design incorporating a number of original features resulting from the Radio Communication Company's long experience in the manufacture and operation of direction finders since their inception for

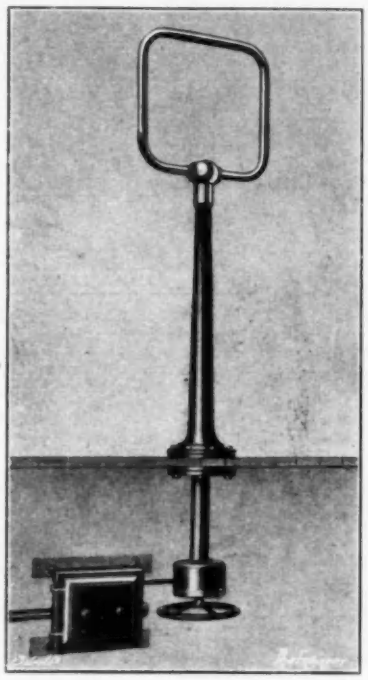


FIG. 19—DIRECTION FINDER—RADIO COMMUNICATION

marine use. Direction finding with this equipment may be carried out on spark, interrupted continuous waves (I.C.W.), continuous waves (C.W.), or telephony transmissions within the wave range of the set. Bearings may be obtained of any ship or coastal station as well as of the many radio beacon stations now operating. The wave range of the set is from 550 m. to 1100 m. thus effectively covering the marine wave band of 600–800 m., the aircraft wave of 900 m., and the radio beacon wave of 1000 m. This wide wave range is obtained, with high efficiency on all waves, by the adjustment of a single tuning knob and without the necessity for independent tuning of the frame aerial or for interchangeable transformers. An important feature of the new design is the incorporation of complete automatic correction of quadrantal and pointer errors. As is well known, the arrival of a wireless wave causes high-frequency currents to be induced in the metal structure of a ship, and these currents give rise to a high-frequency magnetic field. This induced magnetic field is superimposed on the magnetic field of the wave itself and consequently alters the apparent direction of the distant wireless station. The effect is analagous to the change in apparent direction of the North Pole as indicated by a simple magnetic compass when placed in a ship, the steel hull of which is magnetised by induction from the earth's field. The errors introduced both in the wireless case and in the compass analogy are quadrantal; that is to say, they reach a maximum value every 90 deg. The amount of the error in the case of a direction finder depends on the nature of the ship's structure and on the position of the D.F. coils in relation thereto. In a ship having perfect electrical symmetry the induced currents in the structure produce a magnetic field in the thwartship line and the quadrantal error is zero in directions 0 deg., 90 deg., 180 deg., and 270 deg. from the bow, but in many cases the ship's field is misaligned to some extent so that the quadrantal error is zero at four other angles from the bow, though the angles are still separated by 90 deg.

In order to correct a direction finder for quadrantal error it is essential to have (*a*) an adjustment for the magnitude of the ship's field, and (*b*) an adjustment for the ship's field alignment. In addition to the quadrantal error proper a small constant error all round the scale may be caused by slight misalignment of the pointer with respect to the D.F. coil, so that it is also necessary to provide an adjustment for pointer alignment. The equipment under consideration provides a permanent correction adjustment for the above three types of error.

As is well known, a single-frame aerial serves to indicate only a line of bearing, and the method of "sense" indication for obtaining the direction on this line has been much simplified and becomes part of the normal process of taking any bearing. Accordingly only one scale engraved from 0 deg. to 360 deg. is provided. A very high degree of sensitivity is obtained. To indicate this it may be stated that when receiving from a 1½-kW spark transmitter the width of the silence arc is found to be about 3 deg. at 50 miles range and 8 deg. at 100 miles. These figures are conservative, and the width of the silence arc will be decreased with I.C.W. or about halved with C.W. working. The amplifier controls have been reduced to a minimum and consist only of a tuning knob, a reaction adjustment for increasing the sensitivity or for heterodyne C.W. reception, and a "sense" switch. The amplifier is of the superheterodyne type with an intermediate frequency in the neighbourhood of 75 kc/s, and the circuit arrangement successfully overcomes any tendency towards interaction between the oscillatory circuits and the frame aerial. Five low-consumption valves are employed. They include a detector oscillator, two screened grid intermediate frequency amplifiers, one detector with reaction and one note magnifier. On account of the use of a tuned loop and three tuned intermediate circuits, all of low decrement, the selectivity of the amplifier is very great; but, in spite of this, there is no difficulty in tuning-in with the single-knob control. The amplifier is fitted in a heavy metal box giving complete screening and hinged so that the whole instrument can be exposed for the purpose of valve renewal or inspection. The entire structure of the direction finder is non-magnetic, so that the set can be safely fitted near to the standard compass if desired. The frame aerial winding is enclosed in a 2in. diameter copper tube forming a square loop with rounded corners, the outside dimensions being 2ft. 4in. by 2ft. 4in. The frame has a polished chromium plated finish, which is unaffected by exposure. If desired, the coil may be detached and stowed away when not required in position, and it may be replaced again without necessitating any re-alignment adjustments. The frame aerial is supported on a single self-supporting pedestal bolted to the deck. The overall height above the deck is 6ft. 9in., enabling the set to be fitted under an awning if required. The structure has an excellent appearance and does not cause visual obstruction. The hand wheel for rotating the frame and an indicating scale of large diameter are mounted on an extension below the pedestal, and can be fitted over the chart table if required. The scale is engraved on a 10in. diameter circle and each degree thus occupies rather more than one-twelfth of an inch. The reading is therefore very easy to take accurately. The indicating pointer may be fitted in the position most convenient for observation, this being arranged when the set is installed.

The controls, including the quadrantal error correction device, are enclosed and well protected against dust. The extraordinary ease of operation enables bearings to be taken with the utmost speed even by inexperienced operators. After a little practice a bearing can be obtained in about five seconds. The accessory equipment supplied comprises two pairs of head telephones, filament and high-tension batteries, battery charging switchboard, connecting cable and spares.

An interesting piece of apparatus for comparing noises was exhibited by the M.L. Magneto Company, Ltd. The question of obtaining a quantitative measurement of the amount of mechanical noise produced by various types of mechanism is one to which considerable attention has been given. At the present time reliance is generally placed on the human ear as a means of comparing noises, and assigning a noise standard to any particular piece of apparatus, but the human ear has the great disadvantage of accommodating itself to noises varying over an extremely wide range. An instrument that will give a quantitative figure for the noise produced by a mechanism should prove of great value to engineers, but it must not be forgotten that the results given by any such apparatus may not necessarily be the same as that given by the ear. The noise comparator exhibited by the M.L. Magneto Company has been designed to give a quantitative measure for noises of similar character, such as those emitted by ball bearings, gear-boxes, gear drives, electric motors, petrol engines, &c. The apparatus is direct reading, requires no aural observation, and can be operated by an unskilled observer. The apparatus consists of a sound-receiving device which may take the form of a microphone or any convenient method of transforming sound waves into electrical energy. In most cases a gramophone pick-up is employed, as this forms a convenient method of carrying out this transformation. The electric current produced by the pick-up is, of course, alternating in direction and extremely small in amount, so that it is not possible to measure its value directly. In order to obtain a measurement of the current produced, the alternating current is amplified by means of a two-stage amplifier, and impressed on the grid of a third or rectifying valve, which is polarised by a grid bias battery, so as to work on the bend of the anode characteristic. A milliammeter D, Fig 21, is inserted in the plate circuit of the valve, and normally reads zero. When an alternating current is impressed on the amplifier, the resultant alternation in grid potential on the rectifying valve permits a current to flow in the plate circuit and the reading on the milliammeter is a measure of the amplitude of the impressed current, and hence the amplitude of the noise which is being picked up by the receiver. Fig. 20 shows the apparatus for comparing the noise emitted by ball races. The outer ball race is driven through a flexible rubber shaft, so as to insulate it from any noise emitted by the driving motor whilst the inner race remains stationary, and is directly coupled to the needle of a gramophone pick-up. The pick-up is enclosed in a mild steel box packed with rubber, the steel serving to screen the pick-up from any

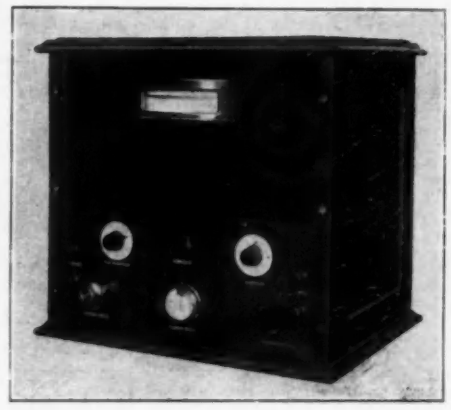


FIG. 20—NOISE TESTER—M.L. MAGNETO CO.

external magnetic field, and the rubber packing serving to insulate it from any extraneous vibrations.

The pick-up, therefore, generates an E.M.F. which bears a close relation to the amount of noise and vibration given by the race. This E.M.F. is applied to the amplifying and rectifying system outlined above.

The E.M.F. from the pick-up is applied to the grid of the first amplifying valve through a resistance E, which serves to control the sensitivity of the apparatus. In order to give an additional control on the sensitivity, the grid of the first valve is connected to the primary of a transformer, the secondary of which is shunted by an adjustable resistance, thus providing a means of controlling the proportion of the total E.M.F., which is actually applied to the grid, and enabling the apparatus to be used over a wide range of sound intensity. The first valve is transformer coupled to the grid of the second valve, a telephone transformer being inserted in the plate

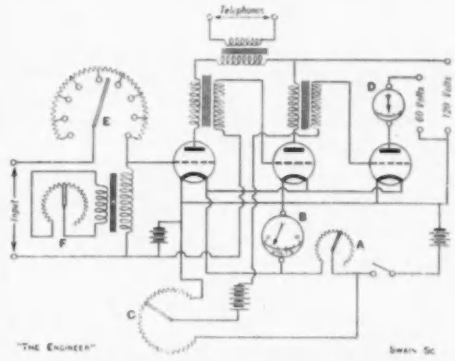


FIG. 21—CONNECTIONS OF NOISE TESTER

circuit to enable aural observation to be made if required. The second valve is also transformer coupled to the grid of the third valve, which forms a rectifying valve and measuring device.

In order to ensure constancy in the characteristics of the amplifier, a voltmeter B is connected across the filament and a filament resistance A is provided, which enables the filament voltage to be maintained at a definite specified value, while the potentiometer permits the grid bias of the measuring valve to be accurately adjusted, so that this valve is always working on the correct portion of its characteristic. Adjustment of the circuits is quite simple, and once adjusted the apparatus can be relied on to give consistent results over large batches of the work which has to be tested. The same arrangement can be utilised for the measurement of such noises as gear-box noise, mechanical vibration from electric motors, or any noise which is emitted by the vibration of a solid body. If an ordinary microphone—or, better still, a microphone of the moving coil type—be substituted for the gramophone pick-up, the apparatus can be used for the measurement of the exhaust noise from petrol engines or any sound vibrations travelling through the air as a medium, and for which the radiating source is not an accessible metal surface. C is the bias control of the rectifying valve, and E and F rheostats for sensitivity control.

Diesel Engines for Passenger Vessels and Fast Cargo Liners.*

In a paper which dealt with the application of the marine oil engine to large ships designed for speeds of 14 knots and upwards, Mr. J. Calderwood gave some interesting particulars with regard to the development of the two-stroke single-acting engine and its advantages compared with other types of oil engines. These he summed up as follows :—For fast cargo liners the two-stroke, double-acting engine had a slight advantage over the single-acting type in that it was lighter and required less space. This was offset by the probability of higher fuel consumption and upkeep costs; but, on the whole, there was little to choose between these types, except that the single-acting engine had the advantage of long experience behind it, whereas it could hardly be claimed that the double-acting engine was as yet fully developed. The four-stroke, single-acting engine, although it is undoubtedly a very reliable and successful type for lower powers, was, he thought, quite unsuited to the class of vessel covered in the paper.

The double-acting, four-stroke engine did not show to advantage in any respect for the types of vessel under consideration. The opposed-piston engine could be classed with the single-acting, two-stroke, as these two types have generally the same advantages over others.

The author remarked upon the present tendency to introduce airless injection, but did he not seem to think that it would be generally adopted until further experience had shown that it was as reliable and consistent in service as was the air injection system. With regard to exhaust gas turbo-supercharging, that system, he thought, could be quite well applied to either the four-stroke or the two-stroke type of engine, and it was not likely to influence the relative positions of these two types of engines.

An interesting part of the paper dealt with the question of vibration, and Mr. Calderwood made reference to his earlier paper read before the North-East Coast Institution of Engineers and Shipbuilders in January, 1928, in which an experimental method of estimating the second and third degree vertical natural frequencies of the hull, and thereby determining the most suitable number of propeller blades, was described. While such a method offered a means of avoiding the commonest causes of trouble, there was need for complete and accurate methods of calculating the various natural frequencies of a ship's structure.

To avoid vibration, not only should the main and auxiliary engines be balanced, but their framing should so be designed that none of the internal forces of the engine were transmitted through the seating or in any other way to the hull of the ship.

Some layout plans showing comparisons of machinery space required with different types of engines and with differing forms of drive, accompanied the paper. In conclusion, the author reviewed briefly the present position and future possibilities of the large Diesel engine. The two-stroke, single-acting type, which was, he showed, particularly suited for the passenger liner, had now reached a stage where about 1000 horse-power per cylinder can be developed without going to cylinder sizes appreciably larger than those that had been tested over long periods in service. It was possible to build a quadruple-screw vessel with twelve cylinder engines, which could develop about 50,000 B.H.P. in continuous service, and such an installation could in no way be considered as experimental. Such a power was sufficient for any except the largest vessels on the North Atlantic service. Higher powers with direct drive must be a matter of gradual development. The adoption of cylinder sizes much larger than had previously been tried had on many past occasions greatly damaged the reputation of the Diesel engine as a whole, and it was to be hoped that no further wild ventures will be attempted, as they are the most serious pitfall in the path of progress. Vessels of the largest and fastest class could be fitted with Diesel engines to-day if the indirect drive were adopted, and while there could be little or no risk in such an installation, it was improbable that any shipowner would invest in so expensive a plant without experience of a similar installation of comparatively large size. Before there was any general tendency towards the adoption of the Diesel engine for Atlantic greyhounds, it was probable that it will have developed to such an extent as to make the direct drive feasible.

For the cargo liner the power required for the speeds called for to-day can be provided by single or twin-screw, single-acting, two-cycle engines. There was still a tendency towards higher speeds, but the development of the Diesel engine was more than keeping abreast of this demand for higher power, and the single-screw arrangement was being more widely adopted even for the fastest cargo liners.

While the direct drive seemed to be the best arrangement for most ships, there were undoubtedly particular services and classes of vessel where electric or other indirect drive would be preferable were it not for its high first cost. This problem was being met by the development of high-speed engines of fairly large power, which would no doubt be widely adopted in future in these special cases. The Diesel engine during the last few years had shown itself to be much the most economical means of propulsion on all services where speeds of from 14 to 20 knots are required, and while the turbine still held the field for the fastest vessels, the Diesel engine was making such rapid progress that before long it will be available for any ship likely to be built during the next few decades.

* A paper read by Mr. J. Calderwood, M.Sc., before the Institute of Marine Engineers, January 8th. Summary.

SIXTY YEARS AGO.

The course followed by British policy in matters connected with China has usually been involved and not always quite creditable. Following the opium war of 1840 the Tsing Dynasty found itself faced with a rebellious populace. In 1852 the movement spread so far that a rival ruler styling himself the first of the Tai-ping Dynasty, was set up at Nanking. In 1857 Britain declared war against the Tsing Dynasty, and having taken the Taku Forts in the following year, eventually entered Peking in 1860. Peace was restored with the payment of a large indemnity, and, encouraged by the return of British friendship, the Tsing Dynasty directed its attention towards its rival at Nanking. The imperialists, aided by a British officer, Major Gordon, of the Royal Engineers, made short work of the Tai-ping faction, and in July, 1864, recaptured Nanking, and drove its enemies out of existence. With the country at peace internally and externally trade rapidly revived, and it seemed to some students of the situation that China was ripe for commercial and industrial development. So at least we sought to argue in a leading article in our issue of January 15th, 1869. We held that nature and the course of political events pointed to the Briton, and in particular to the British engineer, as the party who should undertake the development of China. When the time came to extend intercourse with the Chinese beyond the treaty ports into the interior it was unlikely, so we wrote, that outside this country there would be found men combining engineering genius with love of foreign adventure in sufficient numbers to undertake the task. The establishment of factories, the construction of railways and the discovery of minerals would be our work and ours of right. For the moment, however, British enterprise in China was being embarrassed by the determined resistance of the Peking Government to any progress, and by the languidity of the British Government and its representatives in China. The difficulties likely to be met with by those interested in the development of the country were exemplified by the reception which had recently been accorded to a proposal to construct a short length of railway starting from Canton. The "feeble, corrupt and imbecile" Chinese Government held that railways were inapplicable to China, because the interests of the boatmen on the canals had to be protected, because the agriculturists whose lands would be traversed, would object, because the graves of the dead had to be respected, and so forth. We regretted the day when with our encouragement the Tai-ping faction was suppressed and the "utterly worthless and retrogressive Mandarins" of the Tsing Dynasty were allowed to resume full power over the country's affairs. We urged our own Government to abandon the policy of treating the Chinese rulers with unreal diplomatic equality and to take measures for the advancement of the cause of progress, whether or not such measures were acceptable in the first instance to the Chinese Government.

IRON AND STEEL OUTPUT IN 1928.

It is reported by the National Federation of Iron and Steel Manufacturers that the number of furnaces in blast at the end of December was 132, a net decrease of three since the beginning of the month, five furnaces having been blown in and eight having ceased operations during the month. The production of pig iron in December amounted to 540,400 tons, compared with 544,400 tons in November, and 559,100 tons in December, 1927. The production includes 170,300 tons of hematite, 219,600 tons of basic, 114,200 tons of foundry, and 14,500 tons of forge pig iron.

Production of steel ingots and castings in December amounted to 683,100 tons, compared with 762,500 tons in November and 604,900 tons in December, 1927.

The December production brings the total production for the year up to 6,611,300 tons of pig iron and 8,525,100 tons of steel ingots and castings, compared with 7,292,900 tons and 9,097,100 tons respectively in 1927.

The following table shows the average monthly production of pig iron and steel ingots and castings in 1913, 1920, 1924–27, and the production in each month since December, 1927 :—

	Pig iron, tons.	Steel ingots and castings, tons.
1913—Monthly average ..	855,000	638,600
1920 " " ..	669,500	755,600
1924 " " ..	609,000	685,100
1925 " " ..	521,800	615,500
1926 " " ..	204,800	299,700
1927 " " ..	607,700	758,100
1927—December ..	559,100	604,900
1928—January ..	560,500	626,200
February ..	550,800	764,400
March ..	592,600	793,300
April ..	563,100	644,100
May ..	591,500	752,700
June ..	563,700	709,000
July ..	537,800	666,900
August ..	519,000	648,300
September ..	503,900	718,600
October ..	543,600	756,000
November ..	544,400	762,500
December ..	540,400	683,100

B.E.S.A. SPECIFICATIONS.

ASPHALT ROAD SURFACING.

A series of seven British Standard Specifications for Asphalt Road Surfacing has recently been issued by the British Engineering Standards Association. These British Standard Specifications are based upon specifications prepared by the Institution of Municipal and County Engineers and the County Surveyors' Society in consultation with the Asphalt Roads Association and the Ministry of Transport, and deal with the thicknesses to which the material is to be laid, the gauges of the various constituents and the proportions in which they are to be mixed, methods of mixing, transportation, and laying. The numbers and titles are as follows :—

No. 342–1928.—Two-coat Asphalt (Sand or Sand and Stone Aggregate Wearing Surface).

No. 343–1928.—Two-coat Asphalt (Clinker Aggregate).

No. 344–1928.—Single-coat Asphalt (Sand and Stone Aggregate).

No. 345–1928.—Single-coat Asphalt (Clinker Aggregate).

No. 346–1928.—Mastic Asphalt Surfacing.

No. 347–1928.—Asphalt Macadam (Penetration Method).

No. 348–1928.—Compressed Rock Asphalt.

Copies of the specifications may be obtained, price 2s. 2d. each, post free (14s. 6d. the complete set) from the Publications Department, British Engineering Standards Association, 28, Victoria-street, Westminster, S.W. 1.

The Institution of Civil Engineers.

OCTOBER EXAMINATIONS, 1928.—PASS LIST.

Preliminary (56).

H. M. Alexander, A. A. Babbage, R. I. Bataline, J. Beaumont, J. M. Bett, E. V. Bevan, W. P. Boyd, T. H. Canning, W. F. Caton, G. C. Cole, C. C. G. Daniels, T. H. Davies, C. H. Deakin, M. R. Dharmasiriwardhane, J. J. P. Dolan, R. G. Drummond, T. G. Elliott, W. B. Fairless, C. M. Field, A. L. Fielding, J. M. Foxley, H. S. Graves, N. Greenshields, jun., S. Herson, G. Holden, T. E. Hooley, W. T. Jeffries, S. Khan, C. Lofthouse, G. N. McCarthy, L. C. E. Malt, G. N. Maynard, H. Morton, H. G. Moulding, M. J. Page, J. C. Pridham, A. M. Rankin, H. W. Rispin, W. H. Roden, A. W. Rodmell, W. K. Rodwell, W. D. Sangwin, A. D. L. Shea, N. P. Simansky, C. F. R. Simpson, G. N. Simpson, A. E. Smith, K. E. Trask, W. A. Usher, F. W. Warren, R. W. Watts, R. A. Wheeler, S. K. Wibberley, J. S. Williams, L. F. Wood, G. F. Young.

Associate Membership (276).

Whole Examination (Sections A, B and C) (12).—G. Ashton, J. Y. Danks, J. S. Dowson, R. P. Fish, S. S. Harrison, W. G. Macky, J. Mulgrew, H. F. Sadek, F. C. Sage, E. F. Scott, R. D. J. Scott, W. G. P. Thorold.

Sections A and B only (14).—R. O. Atkinson, H. R. Bach, S. G. Barrett, O. D. Bell, E. H. Booth, T. G. Dewhurst, L. C. Hardie, C. R. Hawkins, E. A. Kanso, H. G. King, H. J. Miller, T. R. Sethna, A. D. G. Wilson, F. R. Wright.

Sections A and C only (5).—W. C. N. Bosworth, A. Johnston, H. Price, N. Singh, J. Tomlinson.

Sections B and C only (17).—E. H. M. Adams, J. C. Ballantine, G. R. Bennett, N. Cook, H. Duckworth, C. S. Gray, S. C. Hardern, D. O. Haskell, J. Hurrell, J. H. Murray, A. N. Peters, J. A. Pidgeon, A. Saleh, P. G. W. Stokes, C. M. Teulon, F. E. Turner, L. F. Weldon.

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Railway and Road Matters.

THE first financial year subsequent to the "appointed day" having expired, the Railway Rates Tribunal has, under the Railways Act, to review the charges of the companies with a view to their revision, if thought necessary. It is understood that the Tribunal has asked the companies for a statement as to their position.

THE death of Mr. C. A. Park at Eastbourne on January 13th is announced. Mr. Park retired in 1916 after holding the position of carriage superintendent to the London and North-Western Railway for thirty years. His father was the locomotive superintendent of the North London Railway and previously of the Dublin, Wicklow and Wexford.

AN unusual accident occurred on Sunday, January 6th, at Bispham, near Blackpool, on the London, Midland and Scottish Railway. A light steel conveyor bridge, for some industrial works, was being erected across the railway, and when a passenger train was going by a girder fell on the train, bringing down six men engaged on the bridge, one of whom was killed. Whilst the records will show this as a fatal passenger train accident, the deceased will be classed as an "other person."

ON page 293 of THE ENGINEER for March 16th last it was stated that the Southern Heights Light Railway was a projected line, 15 miles in length, from Sanderstead, through Chelsham and Cudham, to Orpington, with a junction at each end with the Southern Railway. It was added that it was proposed that that company should equip the line for electric traction at a cost of £140,000 and work it. It is now announced that the Ministry of Transport has made an Order sanctioning the undertaking.

IT has been deduced from statistics that the French railway companies work about 4½ months per annum merely to earn the money to pay wages and salaries of the permanent staff; 2½ months to earn the cost of repairs and maintenance; 2 months to pay taxes; 1½ months to pay interest on debentures; 1 month to pay for fuel; a fortnight to provide for sinking funds; four days only to earn interest for the ordinary shareholders; and less than an hour to pay directors' fees and administrative charges.

IT is officially announced that Mr. S. L. Murgatroyd retires, having reached the age limit, on January 31st from the position of assistant engineer, permanent way, southern area, London and North-Eastern Railway. Mr. Murgatroyd is one of the few survivors of the old Manchester, Sheffield and Lincolnshire Railway, whose service he entered in 1881. His abilities—particularly in the planning and carrying out of sound but economical schemes—brought him very early to the position of assistant engineer. He is being succeeded by Mr. R. J. M. Inglis, now the Glasgow district engineer.

THE Ministry of Transport railway statistics for September also give the results for the nine months ended September 30th, which are of interest in view of the year itself now being ended. Up to the end of September there was an increase of 2·1 per cent. in the number of passenger journeys, but owing to the large proportion of them having been made at reduced rates the receipts fell by 0·6 per cent. The passenger train mileage increased by 3·4 per cent. The freight traffic, on the other hand, decreased 8·0 per cent. in tonnage and 7·5 per cent. in receipts. Freight train mileage was reduced by 3·6 per cent.

IT is officially announced that the Canadian National Railways will ask the Dominion Parliament for authority to construct additional branch line mileage, the work to be carried to completion within the next three years. Sir Henry Thornton, and vice-president S. J. Hungerford, have made a close study of the branch lines required by the system, and their recommendations are now being completed. No details are as yet available, but it is understood that the programme will be somewhat larger than that submitted in 1927, which included 506 miles of new lines. It is hoped to obtain the sanction of Parliament at an early date, so that construction can be proceeded with early in the summer.

A NOTEWORTHY increase in the earnings of the Canadian National Railways is shown by the official statement covering the first eleven months of 1928. The gross earnings amounted to 253,030,877 dollars, as compared with 226,938,406 dollars for the corresponding period of 1927, an increase of 11·50 per cent. Working expenses were 199,481,585 dollars, as compared with 185,478,701 dollars, an increase of 7·55 per cent. Net earnings reached a total of 53,549,291 dollars, as compared with 41,459,707 dollars, a gain of 29·16 per cent. These results show an operating ratio for the eleven months of 78·84 per cent., while for the similar eleven months' period of 1927 the operating ratio was 81·73 per cent.

THE collision at Ashchurch—London, Midland and Scottish Railway—on January 8th, by which two passengers, a railway servant travelling as a passenger, and the driver of the mail train were killed, resulted in the most complete wreckage of passenger stock that we have seen. The circumstances were inquired into, on behalf of the Ministry of Transport, by Lieut.-Colonel Mount on Saturday, January 12th, when evidence was given that, owing to the occupation of the up line, the signalman at Ashchurch Level Crossing Box refused the acceptance of the up mail offered him by Ashchurch Junction Box. The latter man, however, accepted the mail—as he was justified in doing, seeing that he not only had an outer home signal but could set his junction for the branch—but kept his signals at "danger." A drifting fog came on just about that time, and the fog signalmen were sent for. As they had not arrived when the mail was accepted by Ashchurch Junction, the signalman there went to put a detonator on the line to warn the driver. That man must have missed seeing the distant signals—of which, being a triple junction, there are three—the outer home and the three inner home signals, and so ran through Ashchurch Station at 50 to 55 m.p.h., and collided with a rake of twenty-four wagons that were being propelled from the up to the down line at Ashchurch Level Crossing Box. Colonel Mount subsequently adjourned his inquiry and will resume it at Derby, where the fireman of the mail, who has yet to give his evidence, lives.

Notes and Memoranda.

SOME 50ft. reinforced concrete piles were safely driven to a penetration of 35ft. six days after pouring for a bridge over the Illinois River. The concrete mixture was 1–1½–2.

A DISC of glass has been cast in America for the mirror of a large reflecting telescope. It is 69·5in. in diameter by 10·5in. thick, and weighs some 3500 lb. The glass was poured into the mould on May 7th, 1927, and was cooled down, under the control of electric heaters, to room temperature by January 21st, 1928. It contains a few "seeds" and striæ, but will serve the intended purpose.

TESTS of Ontario lignite have produced, according to Premier Ferguson, very encouraging results and demonstrated, in fact, that the lignite in question can be put to any one of several important and valuable uses. By low temperature carbonisation, the lignite could be converted into "char" with a fixed carbon content of 80 per cent. and about 15 per cent. ash, the Prime Minister stated. The char would have a content of 11,500 to 12,000 B.Th.U. and could be made into briquettes having all the desirable characteristics of anthracite coal with quite as high heating efficiency. The lignite can also be burned in its raw state, or it can be pulverised and used under boilers, smelters, and in pulp mills.

IN discussing a paper by Professor J. W. Hinckley, read before the Institution of Chemical Engineers, Dr. W. R. Ormandy mentioned a system which could be applied to the drying of peat, and which was applied on a large scale on the Continent to ball clay and china clay. The wet clay was placed between two conducting surfaces and direct current was passed between the two surfaces, with the result that the water was ejected by endosmosis. Peat containing 93 per cent. of water could be subjected to this process, and the resultant product, containing from 45 to 55 per cent. of water would cake and could be broken up to resemble peat briquettes. The water content of china clay could be reduced to about 32 per cent., and that of ball clay could be reduced to about 28 per cent. in the course of two or three minutes.

A RECENTLY issued official report on the future of a superheater tube on board a turbine steamer is, says the Engineer Surveyor-in-Chief, of special interest at a time when rapid development in the direction of higher pressures and temperatures is taking place. The conditions to which the superheater tubes were subjected originally were, he says, very severe, and the alterations made to improve combustion increased the severity of these conditions. If intense flaming occurs at the superheaters, tube failures are inevitable unless the tubes are adequately protected or unless it is possible to make them of suitable material having special heat-resisting qualities. The experience gained with these boilers and superheaters, which work at a very much higher pressure and temperature than any hitherto fitted on board a British passenger vessel, is valuable in indicating the directions in which improvement is necessary for reliability in high duty marine steam plant.

WRITING on a year's progress in commercial wireless in the *Wireless World*, Lieut.-Colonel Chetwode Crawley says: The advances made in all branches of wireless communication during the past year have been quite as extensive, though perhaps rather less spectacular, than in recent years. In fact, the technical side of wireless has now reached a stage where it has time to pause a little and consolidate its position. Of course, the days of "hit or miss" are long past, but the advent of short waves three years ago did have the effect of throwing into the melting-pot many problems which then seemed to have been solved, and it is only during this last year that we have sailed into less troubled waters. But the pause will be short-lived, many new avenues of advance are opening up, and it will not be long before the melting-pot is in use again for facsimile transmission and short-wave telephony. Later on, we shall be asked to struggle with television, and even, perhaps, the distribution of power by wireless.

IN a review of a year's working of the Holland Vehicular Tunnel, New York, *Engineering News-Record* says that during the year there had been 192 fires in vehicles while going through the tunnel. All of these fires were extinguished by the policemen in the tunnels without the aid of the fire-fighting apparatus mounted on the emergency truck. The great majority of the fires were caused by overheated brakes. On one occasion the fuel tank under the driver's seat of a truck caught fire, but the tunnel police had the fire extinguished and the truck moving out of the tunnel in tow of the emergency truck within six minutes of the starting of the fire. There have been 2190 disabled vehicles towed out of the tunnel by the tunnel emergency equipment; 481 towing chains, distributed throughout the tunnel, have been lent to drivers of other vehicles to take the disabled vehicle in tow; 678 one-gallon cans of petrol have been supplied to vehicles stalled in the tunnel for lack of fuel; there have been 174 arrests, 1370 summonses issued and 4100 warnings for violations of the traffic regulations.

IN order to obtain definite knowledge of the conditions that are most unfavourable to either the ignition of coal dust or the propagation of coal dust explosions, the Safety in Mines Research Board undertook laboratory and large-scale researches in each of these problems. Large-scale experiments carried out at Eskmeals during the years 1923–25, using a steel gallery 38in. in diameter, were described in Safety in Mines Research Board Paper No. 33. The results showed that a rough relationship exists between the content of volatile matter in a coal and the inflammability of its dust. Most of the coal dusts tested in the 38in. gallery were tested during the same period in a steel gallery 7½ft. in diameter, and the results of these tests are described in a supplementary paper just published. The tests made in the larger tube showed that the inflammability of a coal dust, as measured by the mean speed of flame and its explosibility, as measured by the maximum pressure developed, both over a given distance, are approximately of the same order, and that this order is in close agreement with the relative proportion of incombustible matter required to be mixed with the coal dust in order to suppress its inflammability. The tests also confirm the value of volatile matter determinations as a guide to the degree of inflammability of a coal dust.

Miscellanea.

IT is proposed to put up a varnish factory at Regina, Saskatchewan.

IT has been decided to add a tenth, and final, unit of 65,000 horse-power to the Queenston hydro-electric plant on the Canadian side of the Niagara River. The plant will then have a total capacity of 625,000 horse-power.

A PUBLIC-SPEAKING coach was provided at the last annual meeting of the American Society of Mechanical Engineers and many of the authors took advantage of his services. He will be engaged next year, and members who present written discussion will also be given an opportunity to meet him, so that they may improve the forcefulness and emphasis of their remarks.

THE public telephone service between Holland and the Dutch East Indies was opened on January 7th with conversations between the Governor-General in Batavia and the Minister of Colonies and Ways and Means in Holland. The conversations were quite clear. Before noon twenty-six telephone subscribers in Holland and the East Indies had entered their names for calls.

AT the Prescot works of British Insulated Cables, Ltd., 463 employees have had over twenty years' continuous service with the firm, and of the number seventy-five have been with the firm thirty years. Mr. G. H. Nisbett, managing director; Mr. W. Kerfoot, secretary; Colonel Bates, works manager; Mr. A. J. Macphail, publicity manager; Mr. Wolbourn, chief engineer; Mr. Nash, resident electrical engineer, Mr. J. L. Packer, head of cables department; and Miss A. Bradbury, chief secretarial typist; have all had more than thirty years' service. The above numbers only apply to the Prescot works of the company. The total number of long-service medals to be presented by the firm is 813.

AN order has been made by the Board of Trade, under Sec. 427 of the Merchant Shipping Act, 1894, that all ships of 500 tons gross and upwards shall, when going on a voyage or excursion from a port in the United Kingdom, carry line-throwing appliances. These are to be:—(*a*) Four 2 lb. line-throwing rockets, capable of throwing a line ⅛in. in diameter 120 yards in calm weather, together with suitable sticks and with port fires or other means of igniting the rockets; (*b*) two lines of ⅛in. diameter, each not less than 240 yards in length, and having a breaking strain of 150 lb. The rockets, with the means of igniting them, and the lines are to be kept in a watertight case. The order is to take effect on July 1st next.

THE Crown Agents for the Colonies, acting on behalf of the Government of Nigeria, have placed with Head, Wrightson and Co., Ltd., of the Teesdale Ironworks, Thornaby-on-Tees, the contract for the supply of 8800 tons of steel work required in connection with the construction of a new bridge at Lagos. This will replace the Carter Bridge, which was opened for traffic twenty-eight years ago, and which is at present the only connection between Lagos and Iddo Island. All necessary materials and plant for the bridge will be supplied from Great Britain through the Crown Agents, on competitive lines, and the erection work at the site will be undertaken by the Harbour Works Department of the Government of Nigeria. It is estimated that the work, which is to be commenced immediately, will take 2½ years.

DISASTROUS effects of expansion in modern concrete buildings, through changes in atmospheric temperature, were mentioned by Dr. Oscar Faber, the authority on the causes of cracks and decay in buildings, when he recently read a paper at the headquarters of the Royal Institute of British Architects in London. "Dry and seasoned concrete expands with temperature rise very much as steel," he said. "A reinforced concrete viaduct at Sittingbourne is 2400ft. long. This would represent an expansion of 8½in. under certain temperature changes. Clearly, this would be very destructive if no provision were made. The viaduct was therefore divided into 100ft. sections, with expansion joints between, and it was found that the gaps were about ⅜in. less at 3 p.m., after exposure to a hot sun, as compared with 3 a.m. on a cold night."

DIRECT telegraphic communication in both directions between Singapore and London was established on January 7th by the Eastern Telegraph Company, thus eliminating the relaying stations. The new regenerator which has made this development possible is an automatic device, installed at intervals along the line. With this system the speed of transmission is for all practical purposes instantaneous. During tests which were carried out recently a signal was sent from London to Penang and back again in 2⅝ seconds, and transmission between London and Singapore was accomplished in about 2 seconds. The regenerator, it is claimed, is superior both in efficiency and in accuracy to the relaying stations which it displaces. The system was first installed by the Eastern Telegraph Company on the London and Cape Town route some time ago. It was extended to the services between London and Bombay last August, and is now in operation between London and Alexandria also. It is the company's intention to extend the system gradually to the whole of its cable services.

ACCORDING to the *Ironmonger*, a company is being formed, with a capital of £100,000, to develop what is known as the paint "mine" at Bideford, where the mineral deposit commercially termed "Bideford black" is found in a seam running 12 miles east and west of the North Devon port. The Bideford paint mine comprises the only known natural deposit of the kind in the world, and the product is stated to compare favourably with other blacks now used in the manufacture of paint and rubber compounding. The pioneer in connection with the development is Mr. Thomas Thornton, who went to Bideford a few years ago and was a prospector for a local syndicate which intended to exploit the anthracite deposits. The financial obstacles apparently proved insurmountable, however, and the local syndicate sold out. It is understood that Mr. Thornton will be the purchasers' representative on the spot, and that plant capable of producing 8000 tons of refined Bideford black per annum is to be erected. The name of the South Wales Anthracite Trust has been mentioned in connection with the purchase of the mine.

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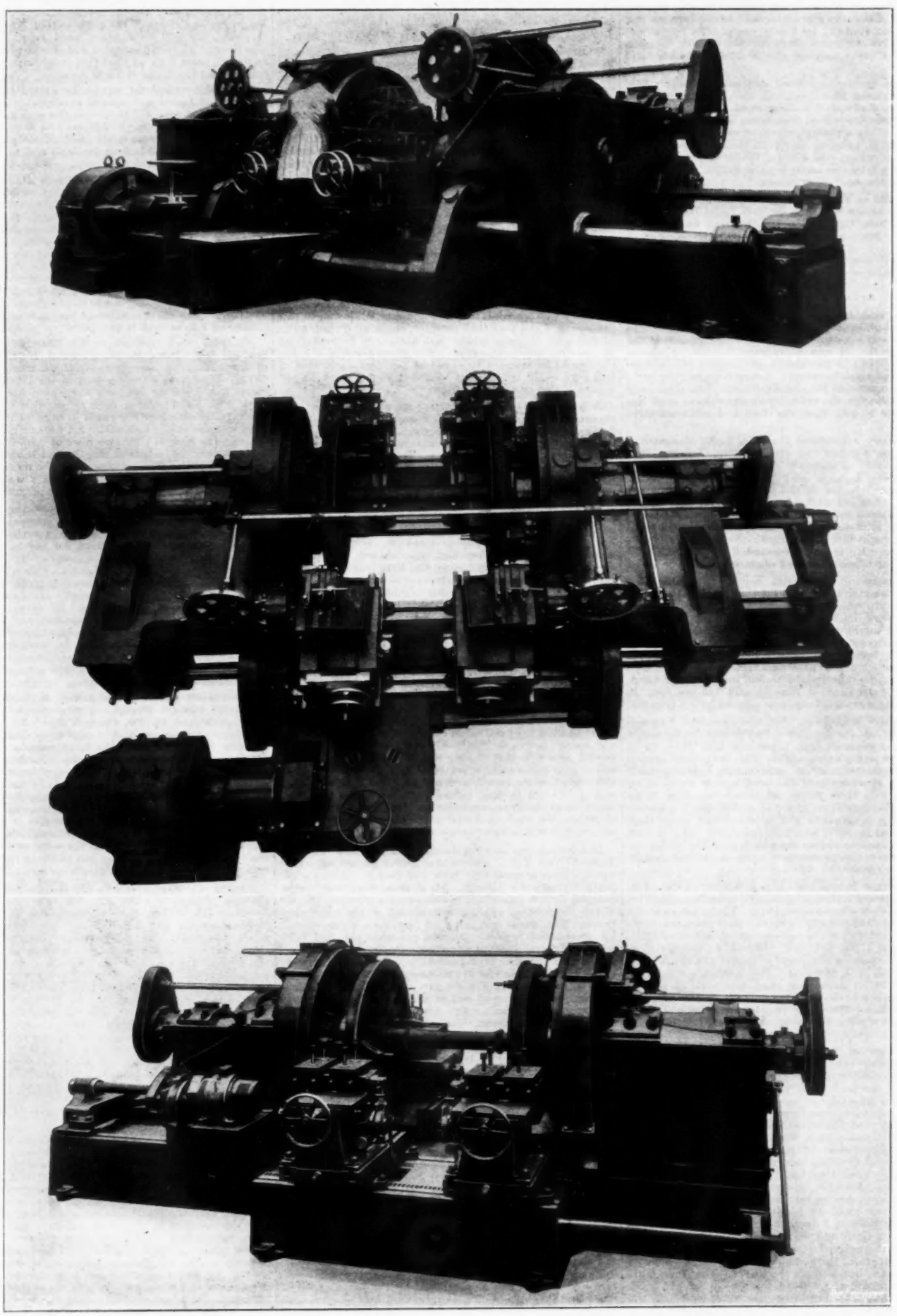

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NOTICES TO READERS.

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DEATH.

ON January 4th, while on a business visit to India, SYDNEY GREENWOOD ROBINSON, director of F. L. Smidth and Co., Ltd., of Victoria Station House, Victoria-street, S.W. 1.

THE ENGINEER.

JANUARY 18, 1929.

The Present Trend in Marine Oil Engine Design.

IF we go back to the days of the earliest ocean-going motor vessels, then the development of the marine oil engine may be said to have extended over a period of from seventeen to eighteen years. For the purpose, however, of gauging the progress made in Great Britain, which early brought our marine oil engine builders to the forefront and has enabled them to maintain the lead in marine oil engine construction for several years past, it is better to take a period of from nine to ten years. That is a comparatively short period when contrasted with the long history of the marine steam engine. At this stage of development it is hardly to be expected, therefore, that an analysis of the present position will reveal any very marked lines of future development. There are, nevertheless, indications that the good seed of the particular types which continue to make progress and thereby show signs of ultimate survival, was sown in the early days. The various fields of application covered by the four-stroke single and double-acting engine, the two-stroke single-acting and opposed-piston engines and the most recent two-stroke double-acting engines must of necessity somewhat overlap. That fact may perhaps account for the partisan spirit shown by advocates of particular types, which often leads them to ignore excellent work done in rival fields. The powers of 3200 I.H.P. and more which can be obtained with a single unit four-stroke single-acting engine are now quite sufficient in twin-screw arrangements to provide adequate power for large and fast motor cargo vessels. With the double-acting four-stroke engine outputs up to a maximum of 10,000 I.H.P. per shaft have been obtained with supercharging, and with twin and quadruple-screw installations of this particular type, suitable propelling machinery for all but the very large Atlantic passenger liners can be provided The two-stroke single-acting engine has made remarkable progress in the last two years, and powers up to 10,000 I.H.P. are obtained in a single unit, and engines of this type are being increasingly employed in single-screw motor vessels. The maximum power for this type of engine was recently given by Mr. J. Calderwood as about 1000 B.H.P. per cylinder, which would enable a cylinder diameter of reasonable size to be adhered to and would make possible quadruple-screw arrangements up to 50,000 B.H.P. total service output. Such a power would meet the requirements of all ships likely to be built in the near future, if the giant Atlantic liners now under consideration and on order be excepted. In the White Star liner it seems highly probable that an oil-electric drive will be used, now that electric propulsion has been decided upon.

The power requirements for all possible kinds of motor ships having been provided for by the various engine types, it is desirable that reliability, together with simplicity in design, should come to be regarded as essential factors in progress. With improvements in design there should also be a reduction in weight and therefore cost. In this connection it is of interest to remark that a French engineer recently gave the following engine weights per horse-power developed as indicating the advance made in the last fifteen years. In 1913 a representative weight was 550 lb., in 1920 it was 330 lb., and in 1927 it was only 110 lb. If we take similar figures for engines of the high-duty naval type the advance made in this respect is more striking. In last week's issue of THE ENGINEER we referred to the 50,000 B.H.P. double-acting two-stroke engines for the new German armoured ship, which on good authority are stated to have a weight of only 17½ lb. per horse-power developed. Recent four-stroke submarine and naval auxiliary engines of British 750 B.H.P. four-stroke design have a weight of only 40 lb. per horse-power. Both of these weights are probably for the dry engine without the fly-wheel. An important advance has been made in recent years on the metallurgical side of oil engine construction, and considerable care is now taken in apportioning the place given to various metals in their design. The better treatment of iron castings has brought with it increased strength and heat-resisting properties, while cast steel is now being usefully employed both for framings and main castings. Alloy steels are also freely used for crank shafts and valves, while the lighter alloys are finding many new uses. It seems likely that aluminium pistons will be utilised in the lighter types of engine. A new form of spherical top end bearing has recently undergone service trials. It gives better access to the running parts and, it is claimed, largely overcomes difficulty with cylinder and piston alignment and liner wear. With the adoption of multiple-cylinder units having as many as ten cylinders the design of crank shafts and balance weights has been modified, and a noteworthy innovation in some four-stroke engines is the introduction of the vertical chain drive for the cam shaft. On the whole the necessity for accurate jigging and machine tool work has raised the quality of workmanship, and this, together with increasing standardisation of design, should tend towards cheaper and more efficient production. It is sometimes pointed out that certain designs of engines are cheaper to make than others, but account is not always taken of the use of modern workshop methods, which may swing the balance in the favour of a less simple design. Again, in actual service the fewer parts of a particular design of engine may be effectually offset by well-thought-out methods of dismantling and overhauling and the provision of useful mechanical aids. The introduction of special exhaust valve grinding machines for four-stroke engines is a case in point.

The interest which is now being taken by builders of four-stroke engines in both the two-stroke single and double-acting forms of construction would seem to point in the direction of the adoption of the double-acting two-stroke engine as the final type for high powers. At present the experience gained on the test bed and at sea with this type of engine is limited, but the success which has been so far achieved will undoubtedly lead to larger engines being built and higher ratings adopted. It may be some time, however, before the present maximum output of the single-acting two-stroke engine is overtaken. Mr. K. O. Keller did well to recall in his recent paper on the difficulties of marine oil engines that greater attention to the combustion side of design was needed. The fact that the performance of oil engines can be increased by scavenging either by the exhaust turbo-blower or fan, or by the introduction of a

separate super-scavenging port, is itself an admission that the cylinder of the ordinary oil engine is not fully charged with air at the beginning of each stroke. If the disposition of the exhaust and scavenge ports in many modern two-stroke engines be carefully studied it will be seen that some degree of stratification of the entering scavenge air with the burnt products within or leaving the cylinder is difficult to avoid. The problems connected with the size, shape and arrangements of liner ports have been investigated by individual firms, but little is known concerning the exact happenings within the cylinder, particularly in the neighbourhood of the exhaust belt. The deposits which have been known to occur on the walls of the liner near this point certainly indicate that some drying of the lubricant undoubtedly takes place, while it is not unlikely that a re-surge of burnt products mixed with cool air may assist in promoting chemical changes in the lubricant which may in turn lead to carbonaceous or semi-carbonaceous deposits being formed, with harmful effects on the liner and piston. Although much has been done on the mechanical side of fuel injection, little is yet known as to the manner in which the oil enters and flame propagation takes place. Such additional information would make sure the present trend of design and lead to a still further advance. Mr. Keller's own engine owes not a little of its success to the happy combination of a through-scavenge combined with a nearly spherical combustion chamber and a well-designed airless injection system. The consumption has been continually improved over the last ten years until the remarkable figure of 0·36 lb. of oil per B.H.P. hour has now been reached. Very close results are reported to have been obtained from the Hesselmann system of airless fuel injection combined with a specially formed combustion chamber, which is an essential part of one of the latest two-stroke double-acting engines built in Germany. In England we await with interest the service results of Mr. W. S. Burns' new type of double-acting two-stroke engine, which has its own special features, both with regard to mechanical details, combustion chamber and system of airless fuel injection.

In this very brief outline we have been able to do no more than indicate by a word or two some of the directions in which progress has been and is being made. When it is remembered that we have concentrated attention mainly upon the work done since the war, it must be admitted that the strides made by the marine internal combustion engine are remarkable. Whilst we must regret that many, nay most, of the types now in use are of foreign origin, yet we may congratulate ourselves upon the fact that the long experience of British marine engineers has played no small part in their development, and we may look with confidence to the continued progress and development of an industry which fits in with all the great traditions of British engineering. There is much work still to be done, and we are confident that our own engineers will play an increasing part in the doing of it.

Telescoping of Railway Carriages.

IN our Leading Article of July 6th last on the railway disaster of June 27th at Darlington, we observed that there was one engineering feature that would, no doubt, receive attention at the hands of Colonel Sir John Pringle who, on the preceding Saturday, had inquired into the cause of the accident. It was the telescoping of the second and third vehicles. On that point we remarked that when two trains met head on, as did those at Darlington, there was so great a disturbance among the vehicles behind the engines that telescoping was almost bound to occur. In fact, although the effects were very unfortunate for those in the telescoped coaches, it was possible that greater rigidity might lead to more serious results. Those observations had reference, of course, to a head-on collision like that at Darlington, but telescoping may also follow from rear collisions, and, as illustrated at Charing Cross on September 19th last, from impact with buffer stops. The matter, therefore, needs consideration generally, and not in respect of Darlington alone. It is worth while noting, in passing, that not until the collision of December 5th, 1910, at Willesden, was the evil of telescoping considered in any accident report. On July 27th, 1903, there was a very bad case at St. Enoch's Station, Glasgow, when sixteen passengers were killed, but Sir Arthur Yorke dealt only, in his recommendations, with "buffer" vehicles and rapid-acting brakes. The Willesden accident was, however, followed, within seven weeks, by two more, *i.e.*, at Hawes Junction on December 24th and Coke Ovens on January 23rd. In reporting on the Willesden case Sir Arthur Yorke said that telescoping was due to the more general adoption of long coaches, with underframes constructed wholly or partly of steel, upon which wooden carriage bodies of relatively light construction, were placed, so that as soon as one frame mounted another there was positively nothing to stop its progress. The report in that case recommended that the designs of the underframes be modified so as to give a considerably increased depth to the ends or headstocks. Sir John Pringle took the Hawes Junction inquiry, and recommended (*a*) uniformity in the weight of rolling stock; (*b*) improved buffering; and (*c*) deepening of the headstocks. The late Colonel Druitt, in reporting on the Coke Ovens accident, said only on this point that consideration was being given to the matter by the railway companies.

Until the unfortunate disaster at Darlington there was in the interval only one other case wherein telescoping had to be considered. It was the head-on collision at Abermule on January 26th, 1921—ten years after Coke Ovens and over seven years before Darlington, or one instance in eighteen and a-half years. In that case Sir John Pringle said: "It is for consideration whether the whole subject of the desirability of equipping passenger stock with devices to resist the tendency to over-ride and telescope should not now be again reviewed by the committee of railway experts at present engaged on standardising carriage and wagon stock." In the Darlington report we find for the first time what may be termed the other side of the question. It is true that in the Abermule report it was observed that railway companies considered that if telescoping were precluded disastrous effects of a worse character would result. Proof of the worse evils that are avoided in collisions when the impact is absorbed by telescoping, was seen at Darlington itself, as there, to quote the report, there was little damage to the fourth, fifth, and sixth vehicles, and the last five were entirely uninjured. Again, at the inquiry by Colonel Mount into the collision at Dinwoodie on October 25th, it was stated that the shock was absorbed in the destruction of the rear fourteen wagons of the goods train, and that only one window was broken in the "Royal Highlander." Now, we have the conclusion—arrived at, it is very important to note, after discussing the general question with Mr. H. N. Gresley—that "it is difficult to lay down any certain preventative action to obviate telescoping. So much depends upon factors of which we have little knowledge, upon irregularities of rail surface, and upon chance." It is however, observed that impact shock effect should be taken up by buffer springs, and by distortion, if the momentum is sufficiently great, of the underframes, but without lifting. Homogeneous strength of springing, of buffering, and of design of solid steel underframing is therefore necessary throughout a train. Sir John Pringle goes on to say that the interval between headstocks of coaches should be as small, and the couplings as short, as practicable for the necessary freedom of movement, so that any tendency of the underframe of one coach to lift will bring its headstock into contact with the headstock of the coach adjoining and possibly prevent over-riding. Non-vestibule stock needs the existing clearance of 3ft. 6in. to allow men to go between the headstocks for coupling or uncoupling. There should either be automatic couplings or heavy steel fenders, corrugated in type, so as to ensure interlocking of the headstocks. As regards, finally, vestibule stock, it is remarked that recent accidents have proved that (1) the buck-eye coupling and the latest pattern—steel-faced—Pullman vestibule, and (2) articulated stock are the best known types for prevention of telescoping. In that relation we would observe that in his report on the derailment of August 17th last at Shepreth, Colonel Trench said that, having regard to the speed and other circumstances the absence of telescoping and the small casuality list were very remarkable, and, in his opinion, it could be attributed largely to the construction of the twin articulated coaches, the two parts of which were close-coupled over their central bogie by a knuckle and pin coupling, which restricted relative movement between the underframes in both vertical and lateral directions. Neither of those couplings was broken. Sir John observes that a number of coaching vehicles, constructed entirely of steel, are under trial; but it is still doubtful how such all-steel coaches will behave under very violent shock when the force of momentum has to be entirely absorbed by the vehicles. It is also admitted that there may be difficulty in effecting the rescue of passengers enclosed in such vehicles.

To design a train which will not suffer severely in a head-on collision at speed is almost impossible without the introduction of some device of a special nature—as, for example, excessively long stroke buffers—to absorb the energy of impact. Imagine the case of an all-steel train with close coupled coaches, and corrugated fenders to prevent over-riding. If such a train were suddenly stopped from a high speed, the probability is that some of the coaches would rear up without over-riding, whilst others might be cast sideways hither and thither on the track. If we may, however, suppose for a moment that it did remain intact upon the rails, the passengers and their baggage would be hurled violently forward. In either case the damage to life and limb could not fail to be serious, and might, conceivably, be greater than that which is suffered generally, in such cases, in the two front coaches. Briefly it would be fruitless to make a train more rigid, if at the same time ample means were not provided for absorbing the blow. Indeed, the more rigid it was, the more likely would it be that passengers from one end to the other would be injured. It may, we suggest, be regarded as axiomatic that to minimise damage there is no other means than the provision of "soft ends." But if railway material had to be constructed with the probability of collisions always in mind, it would be far more complicated and costly than it is now. The only reasonable way to prevent injury to life and limb in such accidents is to prevent them from occurring. It is, we submit, wiser to pursue the search for means of obviating collisions than to endeavour to build trains which could face them with impunity.

American Couplings.

By J. G. B. SAMS, A.M. Inst. Mech. E.

THE question of the American or "Buckeye" type of coupler for railway vehicles has again cropped up, this time in the report of the Ministry of Transport's Inspector on the Darlington collision. As there appears to be a good deal of loose thinking in this country in connection with this type of coupler, it might not be amiss at this time to consider it in relation to the British standard screw and three-link couplings. It can be said at once that the advantages of the British types are that the couplings are low in first cost and have few working parts, and therefore cost little to maintain; that the act of coupling is visible throughout, and the couplings themselves are always in duplicate (that is, one on each vehicle headstock), and if one fails, the opposite one can usually be applied, except in the case of the actual drawgear of the underframe giving out. Further advantages are that the passenger-vehicle coupling is adjustable, so that backlash may be avoided; while the goods coupling, having slack when adjacent wagons are buffered up, allows a heavier train to be handled by any given engine than if the train were rigidly coupled buffer-to-buffer throughout. Their disadvantages are that under no condition will they automatically couple on contact, and that their use necessitates the employment of side-buffers which entails a certain amount of danger to the shunter when they have to go in between vehicles to make coupling or to adjust brake-pipes. The use of a coupling-stick should avoid this danger, but it is feared that through the contempt bred by familiarity the risk of hand-coupling is often needlessly faced.

The writer has recently spent several years on a railway using the standard American A.R.A. (formerly known as the M.C.B.) coupler, and his experience of the subject may be of general interest to railway engineers and others. In the first place it is incorrect to refer to it as an "automatic" coupler, as there are conditions under which it will not couple, or may generally be expected not to couple automatically. The condition in which failure to couple is certain is when both knuckles are closed; failure will frequently occur if the couplers happen to be canted to opposits sides, so that they do not meet fairly on contact, this condition being aggravated when the vehicles are on a curve; again, coupling is frequently missed through the failure of the tumbler-block to fall on the impact of the couplers, probably owing to insufficient impact or to internal rust. The writer tried to overcome the latter cause by graphite blown in at periodic intervals, but the cure was doubtful.

The usual routine when coupling is as follows:—The stationary vehicles are secured by the hand or continuous brakes and the knuckle opened if closed; the moving vehicles are then hit up against the stationary vehicles, the impact between the couplers causing the open knuckle to close; the act of closing lifts the tumbler-block, and when the closing is "made," the block should automatically fall and hold the knuckle closed. The coupling is then tested by a slight snatch given by the engine, if the coupling parts—and the writer has seen this occur five times running—the moving vehicles must be withdrawn

for a space, another and harder impact given, and a further test be made.

The advantages of the American coupler are that it does not require the use of separate buffing-gear, and that it may generally be expected to couple automatically on contact, but the disadvantages are serious, and include slowness of operation, invisibility of coupling, not perfect freedom from danger, cost of maintenance and number of failures, and last but not least, inconvenience to passengers through the jerking of trains. Considering slowness as applying to goods trains, it is certain that the routine of coupling as set out above is a far lengthier business than that of hanging a three-link coupling over the opposite hook, and even if the test be omitted, there will always be a loss of time in discovering and making missed couplings good when a start is made with the assembled train. British railways would be apt to look doubtfully at any scheme that might tend to slow up work in the goods and marshalling yards, although the loss of time might not be so severe if one could see that the block had fallen and that the knuckle was in consequence secured. That there is an element of danger present is proved by the American "Safety First" Council's coloured poster headed "He Pushed it with his Foot," and depicting two vehicles with couplers touching and a shunter lying on a stretcher having his foot bound up by ambulance men. This warning refers to the usual practice of using the foot to push one coupler "fair" with the other, when on the closing of vehicles for coupling, it is seen that the couplers are canted away from each other. The foot is apt to slip and to be caught between the coupler-heads, with disastrous results. It would be of interest to know the number of accidents in the United States through this cause—they are sufficiently numerous to make the Safety First Council issue a special poster. It is probable that the upkeep must cost more owing to the greater number of working parts, but a more serious aspect is that when one coupler fails the opposite one is pretty certain to be rendered useless also. The parts most liable to failure, in the writer's experience, are knuckle-pins, drag-arms (these were specially troublesome), and buckles. Pins can always be replaced by the brakesmen, but the other parts represent total failures and necessitate the use of drag-chains.

Owing to the fact that the slack of the numerous working parts comprised in the complete coupler cannot be taken up at will as with the screw coupling, the total backlash in the couplers of a long train can amount to a considerable and awkward quantity when starting or stopping, and the well known rough starting of American trains is due to this cause. It must also be remembered that the impact necessary to make coupling cannot be altogether pleasing to the passengers. It would be quite possible to provide against this backlash by the use of spring-loaded vestibules or by separate buffing gear, but then most of our trains are not vestibuled, and the fitting of a separate buffing gear would nullify the chief advantage of the coupler.

These remarks are not offered in any spirit of carping criticism, but the objections are serious and ought to be considered before any change of standard is contemplated. Alternatively it should be possible to design a coupler having all the advantages of both types.

Obituary.

SIDNEY RICHARD LOWCOCK.

A WIDE circle of professional colleagues and friends will regret the death of Mr. S. R. Lowcock, which took place on January 9th, after a short illness, at Chard, in Somerset.

Sidney Richard Lowcock was born on November 28th, 1859. He had, therefore, not long completed his sixty-ninth year at the time of his death. He was educated at Merchant Taylors and obtained his first engineering experience during the two years, 1876–78, which he spent in studying at the Crystal Palace School of Engineering, which has, during its long history, produced many eminent members of the profession. From there he went for two years as a pupil of the late Mr. Walter Hunter, a fine all-round engineer, in the works of Messrs. Hunter and English, of Bow, a firm of a type all too rare nowadays—real millwrights—with which a pupil might gain valuable practical experience in all manner of directions. In after life he was wont to speak with gratitude of the amount he learnt during the two years spent at those works in the East End of London. On leaving Bow he was for 2½ years—1880–82—with the Old Kent Water Company—now merged in the Metropolitan Water Board—as assistant Engineer, and subsequently entered the office of the late Mr. Baldwin Latham, whose chief Assistant he eventually became. During the 2½ years—1882–84—that he was with Mr. Latham, he was engaged, amongst other things, on matters concerning Thames pollution and Metropolitan sewage discharge, and he acted as Resident Engineer during the completion of the original Wandle Valley sewage works. Thereafter, he was for two years—1885–87—Resident Engineer on the works of the Birmingham Compressed Air Company, and for two years subsequently he acted as Engineer to that Company.

Since May, 1889, he had, except during the War period, been in practice on his own account as a consulting engineer, specialising in sanitary engineering and water supply. He acted as Consulting Engineer to H.M. Board of Works, the Crown Agents for the Colonies, and the India Office, as well as for a number of County Councils, Corporations, District Councils, and Drainage and Water Boards, both at home and abroad, and he designed and carried out numerous schemes for sewage disposal, waterworks, flood-prevention works, river control, &c. In the early days he did work at Malvern, King's Norton, Stokesay, Chipping Norton, Warwickshire, Worcestershire, Nottingham, &c. He was largely concerned with Government inquiries and parliamentary work throughout his professional career, and within recent years he had been concerned with Bills of the Corporations of Manchester, Croydon, Chepping Wycombe, Grimsby, and Accrington; with Bills for the extensions of the boroughs of Luton, Blackpool, Godalming, and Ormskirk, as well as with the South Essex Waterworks Company. Just prior to his death he had been advising the Epsom Rural District Council and the London, Midland and Scottish Railway, and was actually engaged in carrying out water schemes for Chard and Lympstone and Saunton at the time of his death.

One exceedingly interesting work which he carried out was the remodelling of the water supply of Windsor Castle. During the operations he discovered that some of the original mains, which had been laid about the year 1670, were formed of plate lead, some ⅜in. thick, bent roughly into circular form with the edges, where they met, chamfered so as to leave a V between them. This V had been filled solid by burning in lead, and what appeared to be an excellent joining seam produced.

Mr. Lowcock entered the Institution of Civil Engineers as a Student, and was elected an Associate Member in March, 1885, becoming full Member in March, 1889. He served on the Committee of the Benevolent Fund of the Institution. He was also a Member of the Institution of Mechanical Engineers, and was an exceedingly active Member of the Association of Consulting Engineers from its inception, having been one of the Founder Members and Chairman of Committee for the year 1924–25. From the Institution of Civil Engineers he received, while a Student, a Miller Prize for a paper on "The Water Supply, Sewerage, and Sewage Disposal Works at Wellington College." Later, when an Associate Member, he also received a Telford Medal and a Telford Premium for another paper, entitled "Experiments on the Filtration of Sewage," which was printed in the "Proceedings" for the session 1893–94. The experiments consisted in the aeration of a filter bed of special construction while sewage was being passed through it. At the time but little was known regarding the effect of air on sewage, and the paper disclosed some most interesting results. He was also a Fellow and ex-Member of Council of the Royal Sanitary Institute and a Member of the Institution of Water Engineers, of which he was awarded the President's Prize.

During the War Mr. Lowcock joined the Royal Naval Volunteer Reserve, and was drafted to the Airships Department. In that capacity he visited the United States on a special mission on behalf of the Admiralty. Subsequently, he was transferred to the Royal Air Force and held the rank of Lieut.-Colonel, while acting as head of the Hydrogen Department. He also undertook the laying out and the superintending of the provision of sanitary arrangements and water supplies of various camps.

As a man, Mr. Lowcock was possessed of a charm of manner which endeared him to a numerous body of friends. He was a keen golfer and he enjoyed great popularity during his term of office as Captain of the Engineering Golfing Society in 1923. Some three years ago, with a view shortly to retiring from practice, he removed from London to Somersetshire, but professional calls had, so far from diminishing, actually increased in the meantime, and he had been unable to carry out his intention.

Literature.

Probability and its Engineering Uses. By THORNTON C. FRY. Ph.D. London: Macmillan and Co. 1928. Price 30s. net.

AN overwhelming proportion of the decisions which an engineer is called upon to make are determined by what is called judgment. A sound judgment is really the hallmark of the good engineer. If one tries to analyse what is meant by judgment, it seems to be a faculty for marshalling the pertinent experiences of a lifetime, giving to each its proper weight, and forecasting from the whole the probable consequences of any action. Judgment takes into account all the conditions, imponderable and otherwise, which predicate an event, and thus demands, though this fact is too often forgotten, mental processes of a higher order than those of the mere mathematician who can only act by prescribed rules on data sufficiently simplified to be amenable to formulæ. The mathematician, however, has evolved processes of reasoning designed to give numerical values to the degrees of likelihood which attach to the happening of certain events. He thus gives precision to the idea of probability, and in certain cases enables results to be predicted with a surprising accuracy.

Unfortunately for the engineer, the mathematical theory of probability can only be usefully applied to problems of a limited number of types, all of which are essentially of a statistical nature. But even with this limitation, it has proved productive. Maxwell, by its means deduced the laws of gases from a consideration of the most probable behaviour of their innumerable molecules. Boltzmann showed that the idea of entropy was bound up with that of the probability of different states. Life, fire and accident insurance companies flourish by calculations based on probability. The physicist, the astronomer, and the surveyor all make use of the so-called "law of probability" to decide what values to take when confronted by a number of inconsistent observations. The law is indeed universally employed in such cases, the physicists, as has been jestingly remarked, trusting it because they believed that it has been proved by the mathematicians, and the latter believing that it is justified by the experiments of the physicists.

Many books have been written about probability, but none with a title so likely to raise the hopes of the engineer as this treatise by Dr. Fry. The theory of probability will be of interest so long as anything in the world remains uncertain, and the prospect of applying it to engineering problems instead of to the games of chance, the urns with their black and white balls, and the other futilities of the text-books is an alluring one. Unfortunately those who deduce too much from the title will be disappointed. To Dr. Fry, who is an official of the Bell Telephone Laboratories, in America, engineering would seem to be synonymous with telephony, for if we except the mathematical theory which is common to all branches of engineering and physics, the problems considered are almost exclusively those connected with a telephone system. Generally speaking, they are of no interest to anyone except engineers called upon to decide upon the amount of telephone equipment necessary to give a subscriber a reasonable chance of "getting through" in a reasonable time. No less than sixty-eight pages are devoted to telephonic matters, which to an outsider appear very academic. The goodness of a telephone service depends more on the intelligence and courtesy of the operators and public than upon wonderful calculations on the probability of a certain combination of circumstances existing simultaneously. Congestion of traffic is not nearly so irritating to the subscriber as the daily crop of "wrong numbers" which seem inevitable whether the system be automatic or manual.

So strong is the telephonic note in the book that one rather feels the exposition of telephone problems to have been the main motive of the author. Engineering problems, not connected with telephony, are few and far between. Among such as can be found we note the question whether 6 per cent. of bad screws on a sample of 50 might reasonably occur without indicating bad workmanship, if the average of rejections was 2 per cent. only. There is also a problem relating to the number of cylinder locks which a single master key could open. Another, which may be included, is to determine the stock required at the beginning of each week, in order that not more than 1 per cent. of possible sales shall be lost, the average number of sales per week being known. If we add to these a discussion of the kinetic theory of gases and of one or two more or less recondite physical subjects, in the light of the theory of probability, we have practically all that has any bearing on engineering work.

One cannot help thinking how sadly a good title has been wasted. In all the book we do not find one word about the adjustment of discordant observations, a subject as important in field work as in the laboratory. The term "probable error" does not figure even in the index. Engineers would gladly have given up all the large part of the book devoted to the exposition of general theory with its problems of urns, dice and coins for a discussion of its application to their work. Restricted as these applications are, enough could no doubt be found to make a book. At the moment, as we have pointed out on previous occasions, there is urgent need to make use of the theory of probability in connection with questions of sampling and testing. A quite moderate amount of experimental work would form a basis for computing the "probable errors" of different methods of sampling and testing coal, for example. We should then know the amount of confidence which might reasonably be placed in a single test of a random sample, as compared with, say, continuous sampling or the averaging of a number of tests. In metallurgical work there are similar problems of equal insistence. Within what range of tensile strength, for example, should a number of forgings from a single cast be expected to fall; what proportion should be tested to make reasonably sure that all were acceptable, and so on. If Dr. Fry had justified his title by the inclusion of problems such as these, he would have written a book vastly more useful and interesting to engineers in general.

Heavy Duty Railway Wheel Lathe.

A NEW design of motor-driven heavy duty single-purpose railway wheel lathe has recently been produced by Noble and Lund, Ltd., of Felling-on-Tyne, in association with Alfred Herbert, Ltd., of Coventry. The design is produced in five sizes, namely, to take wheels measuring over the tread up to 37in., 48in., 66in., 78in. and 90in. It differs radically in design from the carriage and wagon wheel lathe by the same makers, described in our issue of December 30th, 1927. In that design the pair of wheels mounted on their axle were supported by a loosely running spindle gripping each end of the axle. The drive was applied by a central headstock midway between the wheels, the spindle, face plates and gear ring of which were formed with a radial gap, reaching to the centre, for the reception of the axle. The gap was not filled in by a loose piece. Instead, the drive to the gear ring was transmitted through two pinions, so placed that one at least was always in mesh with the teeth of the ring. That lathe was also distinguished by the fact that the loading and unloading of the work, the advancement, clamping and withdrawing of the tailstock and the clamping of the tools in the tool slides were effected pneumatically.

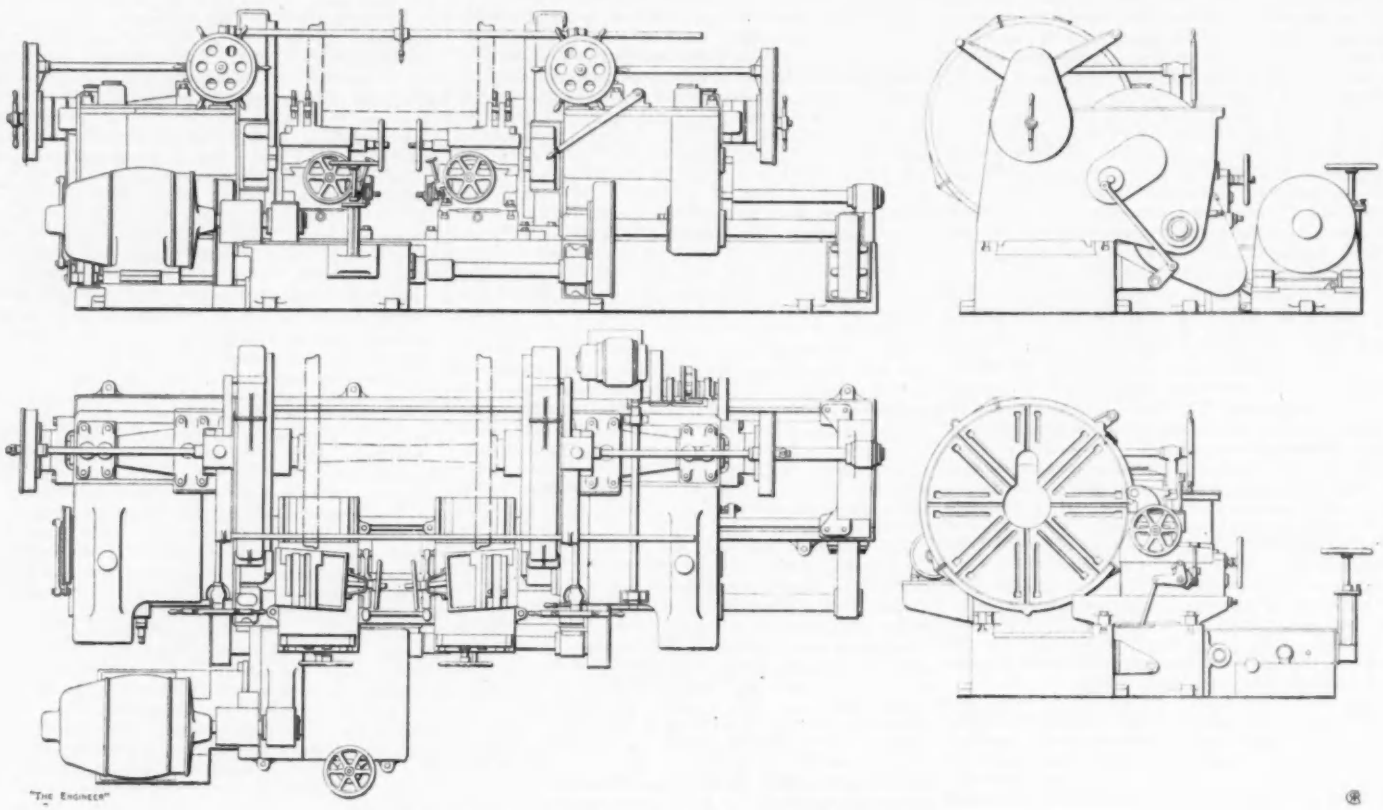
In the new machine illustrated herewith and on page 74 arrangements can be made to fit the tool slides with a pneumatic tool clamping system, but save for that the design bears little resemblance to that of the earlier machine. In particular, the driving details are arranged at the ends of the axle, and are not disposed between the wheels. Nevertheless, the form of drive in the new design is planned to give the same advantages as the central drive of the earlier design, namely, the elimination of long driving shafts and the chattering and vibration which the torsional strain of such shafts sets up.

It will be gathered from the engravings that the driving motor mounted on a base-plate, which is bolted to the concrete foundation, transmits its power through a gear-box, extending from the front of the bed, on to a shaft running longitudinally near the floor level. The drive on to this shaft is received approximately at the middle of its length. From its ends power is taken through gearing to two separate horizontal shafts, serving the headstocks. From each of these shafts power is transmitted through gearing to a horizontal shaft inside the headstock casing. This last shaft ends in a pinion, which meshes with the face plate gear ring at a point just below the level at which the cutting tools act. The individual shafts of the drive are short, and are substantially symmetrical about the driving pinion on the first shaft. As a consequence, any torsion in the shafts between that pinion and the face plate gear rings is equal on both sides of the pinion. The drive, therefore, does not tend to spring the wheels relatively to one another, and hence a fruitful cause of chatter and vibration is eliminated. The makers maintain that the use of a long shaft driven at one end and transmitting the drive to the two headstocks by means of pinions placed at different points along its length is out-of-date practice.

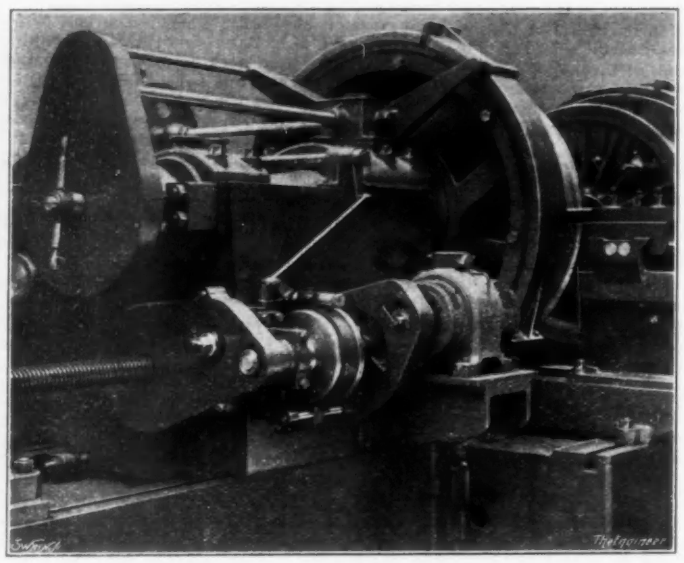
Another factor helping to eliminate the torsional effect is the fact that the speeds of the shafts outside the headstocks are high, the bulk of the reduction taking place inside the headstocks. As a consequence, the torque transmitted by the external shafts is reduced proportionately and hence the torsional strain produced by that torque is also reduced. In other words, the external shafts have diameters well above those required to transmit the required power. Another point connected with the drive which is worthy of note is that the pinions meshing with the face plate gear rings are completely covered, and are supported in bearings on both sides.

The drive has been designed to enable full width form tools to be used without causing vibration, and under test, we are informed, the machine has shown itself capable of fulfilling this object, both on brake hardened and on new tires. The form of drive adopted also has the merit that it preserves the centre of the bed free from shafts. That being so, a chute is formed in the bed which permits the cuttings to be cleared away into a pit in the foundations.

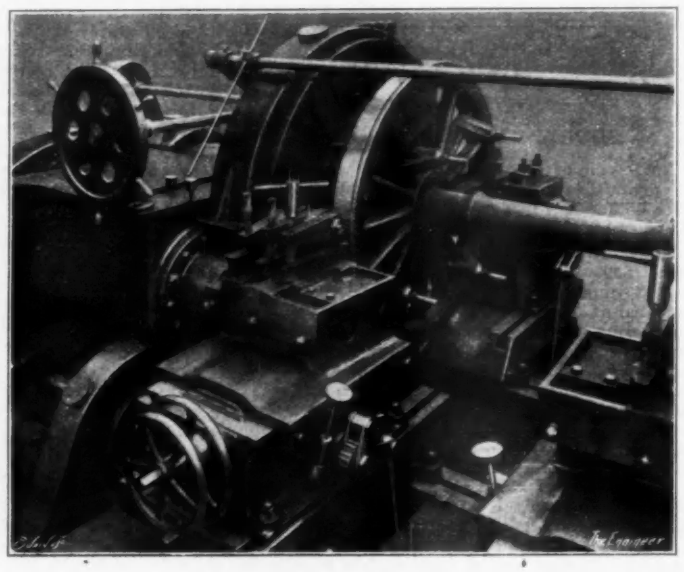
A second feature of the design is the centralisation of all the controls. The gear-box is controlled from a point behind the operator's working position. The changes provided consist of two speeds if a variable speed motor is employed, and six speeds if the motor is of the constant-speed type. One hand wheel serves to control the two-speed box, while two hand wheels are provided for the six-speed box. The gear wheels run in oil and cannot be engaged in a conflicting manner. The headstock is bolted and keyed to the bed. The tailstock is provided with a power traverse along the bed by means of an auxiliary reversible motor, which, as shown in one of the accompanying engravings, is mounted, in order to save floor space, on a bracket attached to the rear of the tailstock. When the tailstock has been run up into position ready to take a fresh pair of wheels, it is locked automatically in that position by means of wedge-shaped projections, which are forced into pockets on the saddle, and in the rear side of



MOTOR-DRIVEN, HEAVY DUTY, RAILWAY WHEEL LATHE



TAILSTOCK AND TAILSTOCK MOTOR



FRONT TOOL REST

the bed. The tailstock motor operates through a friction clutch which automatically slips when the tailstock runs into and is locked down by the pockets.

The main spindles are made of close-grained cast iron. They are of extra large diameter, and work in large bearing surfaces in the headstock and tailstock. Each is equipped with a double ball thrust bearing to take the end thrust. Inside the main spindles there are internal spindles of steel. The front ends of these spindles are formed with a tapered bore, which in the case of axles with outside journals fits on to split tapered bushes fixed to the journals. As an alternative, the internal spindles may be fitted with lathe centres. The internal spindles are operated, to tighten the centres or to grip the outside journals, by means of hand wheels at the front of the lathe. Double-ribbed cast iron face plates are bolted to collars of large diameter cast with the main spindles. Tee grooves are provided on the face plates to receive the driving dog bolts, and in the three largest sizes of the machine the face plates are formed with recesses to accommodate the crank pins of locomotive wheels.

Two compound tool rests are fitted at the front of the machine. The top slide of each of these rests is set at an angle of 1 in 20 to suit the treads of the tires, and is fitted with a feed motion for roughing the treads and flanges. The intermediate slides move parallel with the face plates to feed the tools to the required depth of cut, and for use when a forming tool is being employed. To reduce the possibility of the scoring of the slides by dirt and cuttings the upper slides are made to cover the lower slides over the whole of the traverse. The feed motion is of the intermittent type, and gives several feed impulses per revolution of the spindles. The feeds are independent for each tool rest, and can be varied, started or stopped from the operator's position beside the rests. Steel rules are fitted to the tool rests to facilitate the setting of the tools to the required depth and a trammel bar with an adjustable point gauge is provided to ensure that the two wheels of a pair are turned to the same diameter. The machine, as shown in our engravings, can, if desired, be fitted with two back tool rests, by means of which the sides of the tires can be turned at the same time as the front tools are dealing with the treads and flanges.

All the gearing of the machine is enclosed by guards, and wherever possible is arranged to run in oil. The wheels are of steel throughout, except the first motion pinions, which are non-metallic, and the first motion wheels, which are of cast iron. The teeth are cut by a generating process.

The machine illustrated is the 66in. size. The 37in. size can turn wheels measuring from 24in. to 37in. over the tread, and varying from a metre to 5ft. 6in. in gauge. The spindle speeds range from about 1 to about 4 r.p.m., and the four feeds from $\frac{1}{16}$in. to $\frac{1}{4}$in. The tailstock motor is of 7½ H.P. and the main driving motor of 35 H.P. The bed has a length of about 21ft., and the maximum length of axle which can be admitted is 9ft.

The Quarter's Shipbuilding Returns.

FROM the statistics issued by Lloyd's Register of Shipping regarding vessels under construction at the end of December, we note that in Great Britain and Ireland there was an increase of 153,034 tons in the work in hand, as compared with the figures for last September, although the present total—1,242,794 tons—is 336,919 tons lower than the tonnage which was being built at the end of December, 1927. As compared with that date, on the Clyde there is now a reduction of 16·1 per cent., while on the North-East Coast the decrease represents no less than 42·8 per cent.

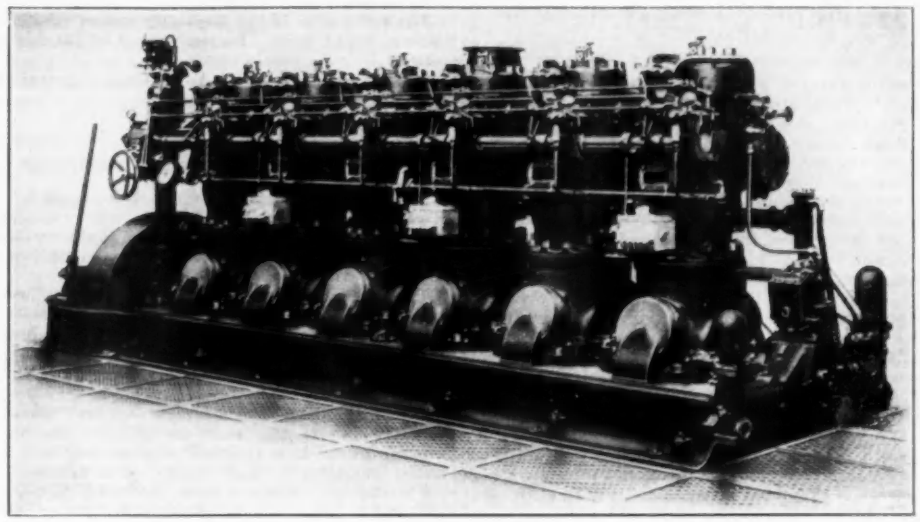
From a diagram issued with the returns—which shows the tonnage being built in this country at the end of each quarter since 1882—it can be seen that the average tonnage under construction during the last six years—1923–1928 inclusive—only amounted to about 1,220,000 tons, as compared with an average of over 2,000,000 tons for 1913, the record pre-war year. It is of interest to learn that about 115,000 tons of the tonnage now in hand in this country are intended for the British Dominions, and about 175,000 tons are for sale or for foreign shipowners.

The tonnage now under construction abroad—1,375,207 tons—is 56,375 tons lower than the work which was in hand at the end of September, but exceeds by 132,000 tons the tonnage being built in Great Britain and Ireland; whereas at the end of December, 1927, the tonnage under construction abroad was about 40,000 tons less than the total for this country. Four countries abroad have more than 100,000 tons under construction, viz.:—Germany, 382,422 tons; Holland, 182,229 tons; France, 161,566 tons; and Japan, 118,580 tons. In Germany, however, the progress of the work during the past quarter has been seriously interrupted. The total tonnage under construction in the world amounts to 2,618,001 tons, of which 47·5 per cent. is being built in Great Britain and Ireland, and 52·5 per cent. abroad; while the average percentages in the last twelve months before the war was 57·2 for Great Britain and Ireland and 42·8 for abroad.

In Great Britain and Ireland 431,758 tons were commenced—an increase of nearly 190,000 tons over the similar figures for the September quarter—and 245,875 tons were launched. Similar figures for abroad are 248,969 tons commenced and 262,000 tons launched. A reduction is again shown in the tanker tonnage under construction, as compared with the very high figures reached during 1927. The present figures are 51 vessels of 361,972 tons, of which 174,376 tons are being built in Great Britain and Ireland, and 63,696 tons in France. While in Great Britain and Ireland the tonnage of motor ships under construction—536,008 tons—is still less than the tonnage of steamers being built, the motor ship tonnage being constructed abroad reaches 859,860 tons, as compared with 506,447 tons of steamers. The world figures for motor ships in course of construction actually exceed by 184,315 tons the similar total for steam tonnage. The continued progress in the employment of the internal combustion engine for marine propulsion is also indicated by the fact that while there are now being built in the world 62 motor ships, each of 8000 tons and upwards, only 22 steamers of such size are under construction.

300 B.H.P. SIX-CYLINDER COLD-STARTING MARINE OIL ENGINE

GARDNER AND SONS, LTD. LONDON, ENGINEERS

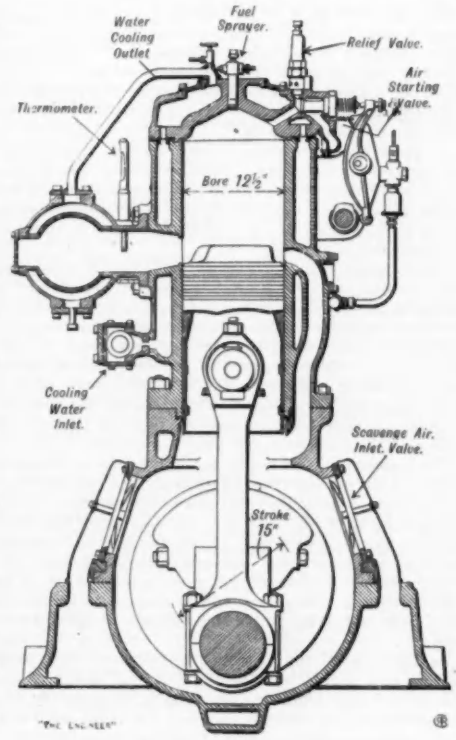


The table respecting marine engines unfortunately does not show complete world figures for marine engines of all types, as the figures for steam turbine engines being constructed in Germany are not available; but the table shows that the indicated horse-power of reciprocating steam engines now being built or being fitted on board amounts to 485,000 horse-power, while the figures for oil engines aggregate more than 1,210,000 horse-power.

The tonnage being constructed throughout the world under the inspection of Lloyd's Register now reaches 1,622,164 tons, of which 1,007,202 tons are being built in Great Britain and Ireland.

A New Series of Marine Cold Starting Oil Engines.

DURING the past few months Norris, Henty and Gardners, Ltd., of Barton Hall Engine Works, Patricroft, and 115, Queen Victoria-street, London (Gardner and Sons, Ltd., proprietors) have introduced in several new motor vessels and yachts a new type of marine cold-starting oil engine. The main feature in the new design, which, we understand, has now been applied to six different



VERTICAL SECTION

cylinder sizes, embracing outputs from 18 B.H.P. per cylinder up to 80 B.H.P. per cylinder and total engine outputs of 54 to 500 B.H.P. at from 250 to 400 revolutions is the adoption of a compression pressure of about 400 lb. per square inch with a combustion pressure of 580 lb., thereby enabling the engine to start from cold. By this means the necessity for any external heating appliance, such as a blow-lamp or internal heating either in the form of electric ignition plugs or slow-burning cartridges, is entirely done away with. Naturally, the new working pressure involved the re-designing of the main castings and the reciprocating parts. We are informed that the new engines are about one-fifth heavier than similar units of the hot-bulb type.

A typical example of the new series is the 300 B.H.P. six-cylinder unit, which is shown above. It has a cylinder bore of 12½in. with a stroke of 15in. and is designed to develop its full output at a normal speed of 290 revolutions per minute. The main features of the design are to be seen in the drawing showing a section through one of the cylinders. The bed-plate is of the girder type and the oil sump forms a part of the main casting. The individual crank case castings are bolted direct to the machined face of the bed-plate. A light cover encloses the crank case scavenge air inlet valves, and the air is drawn through the bed-plate spaces, which makes for silence in the engine-room and at the same time ensures cool bilges. As shown below, a combined liner and water jacket casting is used, and this casting is spigoted and bolted to the upper flange of the crank casing and carries the cylinder head. It will be seen that a symmetrical design of cylinder head has been adopted, which has a loose upper cover giving access to the water spaces. The cylinder joint is made metal to metal without a gasket, and the water connections are rendered tight by the use of rubber rings. The fuel sprayer is centrally placed and the single opening at the front of the cylinder head serves for the relief valve and the air starting valve. There are separate fuel pumps for each cylinder and the fuel injection pressure is about 2000 lb. per square inch. The cooling water enters the lower part of the liner water jacket from a longitudinal cooler through which a distributor for the bearing lubrication system passes. The outlet is at the top of the cylinder and the heated water passes through a central outlet cock back to the water-cooled exhaust manifold. The fuel pumps are wedge-controlled from the vertical centrifugal governor, which, along with the central pillar, is placed at the fly-wheel end of the engine. The cam shaft, which runs along the front of the engine at mid-cylinder height, carries manœuvring and air starting cams in addition to the fuel valve cams. It is driven from the main crank shaft through skew gearing.

References has already been made to the arrangements for cooling the lubricating oil from the main bearing pressure lubrication system by a tube within the cooling water manifold. This cooler is furnished with filters and the system is extended to the air compressor and the bilge and circulating pumps, which are all mounted on the bed-plate at the forward end of the unit and are driven by an extended crank on the main crank shaft. The air compressor is of the two-stage type with a first stage pressure of 80 lb. per square inch and a final pressure of 350 lb. Air starting can be fitted to as many cylinders as may be necessary.

The reversing is carried out by a single control wheel on the governor pillar and the speed of the set can be quickly altered from 290 revolutions per minute down to about 95 revolutions. Recent shop trials made with one of these engines running on Diesel fuel oil of 0·88 sp. gr. showed a full-load fuel consumption of 0·402 lb. per B.H.P.-hour, 0·410 at three-quarter load, 0·456 at half-load, and 0·60 at quarter load. These figures would be slightly increased for the smaller sizes of engines. Noteworthy ships to which such engines have recently been fitted include the yacht "Monica," constructed by Camper and Nicholsons, Ltd., in which two 300 B.H.P. units were installed; and the new cattle carrying motor vessel "Bovril," built for the Argentine Estates of Bovril, Ltd., by John I. Thornycroft, Ltd., at Southampton. This vessel, which is fitted with two 200 B.H.P. engines of the type we have described, recently made a successful maiden voyage to Buenos Aires. Engines for several other yachts and ships are now going through the works.

A RECENT incident adds strength to the comments made by Colonel Sir John Pringle in his last annual report—for 1927—on railway accidents as to the frequency of coupling failures. On Wednesday, January 2nd, a heavily laden goods train of fifty-four wagons drawn by two engines, from Liverpool to Bradford, on the London, Midland and Scottish Railway, became divided near Eastwood. The signalman at Hebden Bridge noticed it, and stopped the first portion, with the result that the second portion, which, owing to the falling gradient, was following, ran into the first with such force that all the four running lines at that point were completely blocked.

Letters to the Editor.

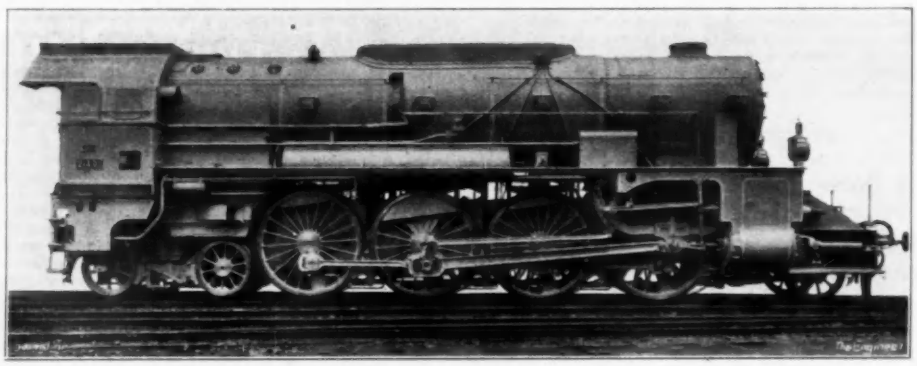
(We do not hold ourselves responsible for the opinions of our correspondents.)

THE HEAVIEST EUROPEAN PASSENGER LOCOMOTIVE.

SIR,—As a constant reader of your esteemed journal I have for years followed the interesting articles which you devote to locomotive problems, and have seen the summary of last year's designs in your issue of January 4th. Although I know that England, the classic country of fast railway service, prefers the light express engine to the monsters that are gaining ground in other parts of the world, it may be of interest to you to know that special conditions induced the Austrian Federal Railways to order the heaviest and most powerful high-speed locomotives of Europe. I have pleasure in enclosing a photograph which, I hope, may serve to supplement your review of the locomotives of 1928. Locomotives of the Series 214 will represent a good example of the progressive tendencies which the Austrian railways follow in spite of adverse conditions and the destructive effect that the world war had on this country.

The first of the series, which was delivered by the designers and builders, the Wiener Locomotivfabriks A.-G., in December, 1928, is designed to pull in every-day service a train of 550 to 600 (long) tons over a 1·0 per cent. gradient at 40 miles an hour, and to attain a high average speed by rapid acceleration in spite of frequent stops or speed restrictions, while the maximum speed should be 69 miles per hour. The axle load was restricted to 40,000 lb.

This difficult problem was solved by the builders by adopting the 2–8–4 wheel arrangement in connection with a simple two-cylinder steam engine, working at 213 lb. pressure. A special feature is the cast steel frame, which runs in two pieces from the front end to the last coupled axle. It is expected to reduce materially maintenance costs of frames and machinery. Maximum overall efficiency was the leading factor.



AUSTRIAN FEDERAL RAILWAYS—EXPRESS PASSENGER LOCOMOTIVE

Table of Dimensions.

Machinery—	
Cylinders, diameter and stroke	25·6in. by 28·4in.
Valve gear	Walschaerts
Valves	Double seat poppet type
Driving wheels, diameter	76·4in.
Boiler—	
Type	Straight top
Steam pressure	213 lb.
Diameter, first ring outside	79in.
Length between tube plates	19ft. 8in.
Heating surface: Fire-box	204 sq. ft.
,, ,, Tubes and flues	2850 sq. ft.
,, ,, Total evaporating	3054 sq. ft.
Superheating surface	1076 sq. ft.
Heating surface, total combined	4130 sq. ft.
Grate area	50·8 sq. ft.
Weights in working order—	
On drivers	155,000 lb.
Total locomotive	260,000 lb.
Total locomotive and tender	388,000 lb.
General data—	
Tractive power at 85 per cent. boiler pressure	44,100 lb.
Factor of adhesion	3·52
Length over buffers	49ft. 4in.

The steam distribution is effected by a Lentz poppet valve gear, and the feed-water heater is of the Dabeg open type; the pumps are driven by the main engine. Special attention has been given to ample area in the live steam and exhaust passages and a novel front end arrangement reduces the back pressure to a negligible amount.

An abnormally long main connecting-rod—14ft.—keeps down the vertical thrust on the driving wheels. It was possible, through careful designing and the use of special materials, to get the weight of reciprocating parts as low as 1300 lb.

The four-wheel trailing bogie permits the use of a simple straight fire-box. Its introduction on a tender engine took place in 1909 when Mr. Goelsdorf designed the first "inverted Pacific" or 2–6–4 type of locomotive for the Austrian State Railways. A total of ninety-nine locomotives of this kind are doing excellent service.

The photograph gives a good idea of the imposing appearance of this engine, especially if it is considered that the boiler centre lies 11ft. 2in. above rails, the highest location in the world.

The first engine is just beginning its test runs on the line mentioned above. Its results may be watched with interest.

ADOLF GIESL-GIESLINGEN.

Vienna, Austria, January 9th.

BRITISH ENGINEERING DESIGNERS.

SIR,—In your leader of January 11th, entitled "The Market for Engineers," you mention our "disquieting dependence upon foreign design," and appear to suggest that the fault lies with the engineering designers of this country.

There is no doubt that some firms have had somewhat unfortunate experiences through entrusting important designing work to college graduates with little experience either of design or of practical work; the faulty designs not being discovered in time, either owing to the lack of expert knowledge of design on the part of the managing directors, or to their being otherwise engaged. The writer believes, however, that there are large numbers of men working in our drawing-offices, who not only have theoretical knowledge but have also served as apprentices in the workshops. Many of these men are quite as good practical designers as those of fifty years ago.

The true reason for our apparent dependence upon foreign design is, in the writer's opinion, that the designers of to-day have a lower standing in our engineering works than the designers of fifty years ago. The ordinary and leading draughtsmen are better off than they were in the past; but the men responsible for original design are now ranked merely as high-class draughtsmen. They have, as a rule, no real position or influence in their firms, and never come into contact with the boards of directors.

Fifty years ago the heads of firms were themselves expert designers and draughtsmen.

In your obituary notice of Sir John I. Thornycroft, in your issue of July 6th, 1928, the portrait you publish of the late Sir John, shows him at the drawing-board and in the act of using a slide-rule. Sir John would then be about seventy years of age. In his young days he was a draughtsman at Palmers.

The founders of practically all our leading engineering firms were, like Sir John Thornycroft, accomplished draughtsmen and designers, and the pioneer work of their firms was originated by them on the drawing-board.

Pioneer work means risking money; and no one in the subordinate position of most of the designers of to-day in this country could possibly do pioneer work such as was done by Sir John Thornycroft and similar distinguished engineers, as from their subordinate position they cannot command the confidence of boards of directors.

The commercial and purely managing sides of engineering are much more attractive to those men who are born to high positions or have considerable capital at their disposal, as they can begin to undertake important work without much experience. To become a good designer, however, great technical and practical knowledge is required; and many months of arduous work have to be spent at the drawing-board and in the study, before the capability of making important original designs can be attained.

At least one of the managing directors of every engineering firm should be capable of original design; and the writer believes that the few firms in this country who are prospering at present have real technical engineers, with designing ability, among their managing directors. The foundation of the success of every engineering firm lies in their designing office. If a firm's designs are bad, the commercial department is helpless.

The humiliating policy of purchasing foreign designs, often of very doubtful merit, and sometimes definitely bad and wrongly proportioned, cannot be too strongly condemned. It is very questionable if the great majority of these purchased designs have ever earned dividends for the unfortunate shareholders.

Some of these foreign designs are undoubtedly quite good, and a very few are outstandingly excellent; but in most cases the purchase is quite unnecessary, as there is no monopoly, and any patents are of doubtful value. Equally good or better designs could usually have been made in this country, without infringing any patent rights. It is curious in how many cases distinguished firms in this country have blindly worked to the dimensions given in purchased designs. The secret history, in past years, of the results of trusting implicitly to certain of these purchased designs, if it could be published, would be startling.

January 14th. CONSULTANT.

THE MARKET FOR ENGINEERS.

SIR,—Your leading article on the above subject calls for some comment. The first impression it conveys is that the industrial branches of engineering are full of university men. The numbers of engineering students who have actually taken degrees in any one year can be estimated, from the statistics furnished by the University Grants Committee, to be not more than about six hundred. This figure embraces every branch of engineering, and includes the not inconsiderable number who, in a commend able spirit of adventure, seek their opportunities abroad. It includes also the large number of engineering students from overseas who come to our universities for their scientific training and then return to their own land. It will be seen, therefore, that the proportion of entrants into industrial engineering who come from the universities, compared with those who are recruited in other ways, must be very small. It must, indeed, be somewhat rare to meet a university man in an engineering works. If the increasing dependence upon foreign designs to which you refer has any connection at all with the university trained man, it must be to his absence from, rather than his presence in, the industry. The significance of the fact that such designs are produced in countries where scientific training is more universal, and carried to a much further degree than in this country, cannot be dismissed in the peremptory manner of your article.

The charge that the technical training of an engineer by attendance at a full time course at college was intended to supplant the practical experience obtained in works dates from the foundation of engineering schools in the Universities of this country. Nothing was further from the minds of those who founded them. It is a claim never made by university teachers since that time, and it is both surprising and disappointing to find this matter raised again in an attempt to compare the relative merits of scientific training and of works experience as if they were alternative methods of producing engineers. The necessity for experience is axiomatic, and beyond argument. It is nevertheless true that experience alone, unaided by scientific training, can only lead to stagnation of ideas.

It is, however, encouraging that there are important engineering firms in this country who place sufficient value upon a university training that they send their representatives to the colleges to interview and select suitable candidates for entrance into their works, and, moreover, provide them with the means of keeping body and soul together during their works training. No student who has passed through the engineering department of this college is, as far as I am aware, at present without a job. Not all, however, find themselves in that branch of engineering which they would most desire and for which they may be best fitted. This circumstance compels me to refer to your remark concerning the "college graduate who has been *fortunate* enough to acquire a good subsequent training in the works." (The italics are mine.) So long as it is a matter of good fortune, in certain branches of engineering, to get the opportunity of acquiring a good practical training, so long will it be difficult to find men with the necessary qualifications, both scientific and practical, to meet foreign competition.

J. COOK,

Professor of Mechanical Engineering.

King's College, London, W.C. 2, January 15th.

SIR,—Please permit me as an engineer of fifty years' experience to congratulate you upon the excellent leading article, "The Market for Engineers," in your issue of the 11th inst. In the interests of the engineering profession it is to be hoped that your article will receive attention from those about to enter that profession.

It is frequently contended that few, if any, young men of the present generation are fit for study and attendance at science classes after a day's work in the shops. It is doubtful whether the contention is correct, particularly as shop hours to-day are shorter than in former days, when apprentices employed on machine tools worked from 6 a.m. until 7 p.m., and often attended science classes from 8 to 10 p.m. on four or five evenings a week.

The survivors of the old *régime* and the younger men who follow their example have so far leavened the lump, it would be interesting to know what will happen when they no longer do so, and every engineer who aspires to leadership is college trained.

Under the old system the young engineer at an impressionable age was in daily intercourse with the class of men whom he hoped one day to lead, and thus acquired an insight into their habits of thought, which became a valuable asset in later years. The college trained man has no such opportunity even although college and works training are on the sandwich system, as the workmen regard him as of a class apart from themselves; moreover the training he receives, while it may enable him to "tell," seldom enables him to "show" a man how to do a job. Nevertheless, advertisers usually select the college man for responsible positions, and when the modern youth sees the difficulty the practically trained man has in obtaining an adequate financial return for early hard work and

sacrifice of leisure, it is not surprising that the less arduous and what is by some considered the more gentlemanly alternative of the college course is preferred.

ONE OF THE OLD SCHOOL.

London, E.C. 4, January 14th, 1929.

SIR,—The leading article in your issue of January 11th under the above title is of considerable interest, but it is hoped that you will pursue the matter further. As I read the last paragraph and reached your statement—doubtless true—that England now relies to a large extent on foreign inventions, I paused a moment and wondered how this fitted in with your argument, viz., that theoretical training was overdone in this country, whereas on the Continent such training is, if anything, more intensive. Turning again to your article, I continued, hoping to find the answer, but the writer apparently found it too much for him, and explained the matter away by stating that conditions, men and education are different on the Continent, and in any case we are concerned with conditions at home.

What one would like to know is, How is it that on the Continent practical inventions are turned out by men highly trained in theory, whereas, according to you, Sir, if inventors are to be produced in this country there is nothing for it but a thoroughly practical training.

I think, however, if you look further into the matter you will find that the university training on the Continent is in many respects superior to ours. I imagine it is sounder on fundamentals, and, finally, is not divorced to such an extent from the works. Furthermore, as THE ENGINEER has frequently pointed out, inventors in this country get little encouragement from financiers and so-called business men, who now control many of our engineering concerns. These men think it good business to buy continental patent rights instead of "wasting" money on research.

J. M. SHACKLETON.

Preston, January 15th.

THE CHANNEL TUNNEL AND BROAD GAUGE.

SIR,—That very excellent proposal, namely, to consider again the building of a Channel Tunnel, compels one to think, and sometimes rather boldly, as to the possible future. During the last few years I have had various problems to deal with, in the design of suitable railway locomotives, for operation at much higher speeds than those which are at the present day attained, on our narrow gauge (4ft. 8½in. so-called standard) railways, and with a view of not only higher speeds, but also to hauling heavier trains at those speeds.

The limitations of this really uneconomical narrow gauge and the constricted loading gauges of our various railways prevents the design and construction of really efficient hauling locomotives, and it is a very pertinent question, from the national aspect, if the Great Western Railway directors really made a wise step in converting the famous "Brunel" gauge to this toy gauge, when considering the undoubted and essential requirements of future generations.

As years go by, from the morning, May 20th, 1892, when I remember the big single driver, and very fine locomotive, starting on her journey from Paddington upon the last of the runs to Penzance on the roomy broad gauge railway, one wonders indeed how it was that the enlightening visions of England's most brilliant engineer were to be so condemned. Any experienced locomotive designer knows full well what it has meant ever since, and the forcing up of wasteful boiler pressure in order to obtain the essential tractive effort to handle the present-day loads. The public are at least now beginning to appreciate what it would have meant to them, when travelling in the very much more roomy and comfortable broad gauge carriages, and the higher speed, at lower rolling resistance, which the larger diameter carriage wheels brought in their train; and the much greater stability and safer riding which was secured even when travelling at over 100 miles per hour. The "Brunel" broad gauge had all the essential features for the safe attainment of this life-saving "speed," plus the also significant essentials for obtaining speed with thermal economy.

With the much greater space allowed for in the broad gauge, larger cylinders, at lower pressures, and a great reduction in bearing pressures are possible, with all their valuable features concerning the cost of maintenance and, above all, "reliability," whereas with these high-pressure types of steam locomotives in use to-day, and the restricted space available, high bearing pressures, (with a result—like little dogs—they are always running hot, and give any amount of real trouble, compared with the old broad gauge locomotives even in Dan Gooch's time) are necessary.

The last run of the broad gauge trains took place only eight years before the first of those historic road races, "The Gordon-Bennet Races," in 1900, when the great potentialities of, and the reliability of the internal-combustion prime-mover, were put to the test. It makes one think what could have been done to-day on the famous Great Western if the directors had just held their hands for a few years, before taking any serious notice of the clamourings of the evidently narrow-minded narrow-gaugers of the period. There is, however, one consoling feature, and that affects the shareholders of that indeed well-advanced railway. It is the fact that the Great Western will be the cheapest railway system in the world to re-convert back again to the broad gauge, in the probably early future, because, of course, all the tunnels, &c., still have broad gauge loading measurements, &c.

The recent suggestion which has been made to build an entirely new railway between London and Paris on a broad gauge, seems to me to have more sound foresight in it than appears perhaps at first clearly, and whatever takes place ultimately in connection with building a Channel Tunnel, it is to be hoped that the widening of the gauge of the short run to Dover, and the not great distance to Paris, on the existing railways, will be found worthy of serious consideration, when thinking of the increased tonnage which will no doubt have to be handled, and at a possible much higher train speed. This refers not only to passenger but also to freight trains.

WILLIAM P. DURTNALL.

London, S.W. 1, January 12th.

IDENTIFICATION PLATES ON MACHINERY.

SIR,—There is a point of interest which I take leave to put forward, and that is the method of numbering engines, machinery and boilers, with makers' numbers and other relevant details stamped on a brass plate, which is fixed to the machinery by small brass screws. These plates can, of course, be easily removed, and thus any record or register of the machinery is lost. It also opens an avenue to fraud in the event of a transfer or sale, and such is my personal experience in this country. I beg to suggest that all machinery for export should have the maker's number and relevant details stamped on the machinery in a prominent position on a part which is not likely to be changed at any time, such as an engine-bed plate. Removable brass detail plates can also be fitted if desired, but I consider in this country some such ineradicable number should certainly be stamped on all machinery.

I find it also makes it practically impossible to trace machinery if same has been transferred or sold and keeping of registers a difficult matter.

W. M. VACY-ASH,
Inspector of Boilers, Factories and Electrical Installations in Baluchistan, Quetta (India).

Quetta, December 20th, 1928.

Books of Reference.

GARCKE'S "Manual of Electrical Undertakings," Volume XXXI. 1927–1928. Published by the Electrical Press, Ltd., 13/16, Fisher-street, Southampton-row, London, W.C. 1. Price 35s. net.—The contents of the present volume have, we are told, been revised and corrected to September, 1928, and include analysed accounts for 1927–1928 of the municipal and company undertakings in all branches of the industry. "Garcke" really needs no word of introduction from us—it is too well known—but we may say that the present issue contains particulars of about 5000 undertakings, divided as follows:—Supply in this country:—Companies, 624; Municipalities and other bodies, 447; Traction in this country:—Companies, 123; Municipalities, 159; Telegraphs and Telephones:—Companies, 42; Municipalities, 2, and the Government Departments; Manufacturing and Allied Companies, 818; and Colonial Undertakings, about 2700. We learn that at the present time the total amount of money invested in this country, omitting the capital for Government telegraphs, now reaches a total of over £870,000,000. In this year's volume there are twenty-six maps of electric tramways, railways and power undertakings. The Directory sections now contain over 20,000 names.

"ICE and Cold Storage Trades Directory, 1929." London: Iliffe and Sons, Ltd., Dorset House, Tudor-street, E.C. 4. Price 11s. post free.—This is the twenty-fourth issue of the only annual reference book of its kind in this country. The usual extensive revision has been given to the new edition, and some hundreds of names have been added to the classified trade section. The number of trade headings has been noticeably increased, and full particulars are given of some fifty-four new companies formed during the past year. As a book of reference its value is considerably enhanced by the number of tables and amount of refrigerating and cold storage data given. It is evident that the compilers of this directory have taken much trouble to make it of great value to those engaged in the cold storage, ice-making and refrigerating industries.

"THE South American Handbook, 1929." Edited by J. A. Hunter. London: South American Publications, Ltd., Atlantic House, Moorgate, E.C. 2. Price 2s. 6d. net.—The sixth annual edition of this handbook follows closely the lines of previous issues, and the statistics which were contained in them have been revised, while the general information brought up to date. The book is well called "South America in a Nutshell." It opens with a chapter on the South American Continent in general, followed by separate sections dealing in detail with each of the countries. For the traveller this little volume should prove useful as a guide-book, and the business man will find in it a mine of information as to local conditions, climate, population, duties, &c.

"THE Colliery Manager's Pocket Book for 1929," which is published by the Colliery Guardian Company, Ltd., 30 and 31, Furnival-street, Holborn, E.C. 4, price 3s., appears in its customary serviceable shape and form. In addition to the usual week-to-a-page Diary there are, among others, sections devoted to the following:—"Mining Progress during 1928," "Coal and Its By-Products," "Surveying," "Mine Ventilation," "Rescue and Ambulance," "Strength of Materials," "Machinery," "Explosives," "Approved Safety Lamps," "Electricity in and about Mines," "Valuation," "Depreciation," &c. Particulars are also given concerning Inspectors of Mines; Government Offices, Departments, and Committees; Mining Institutes; Trade Societies, &c. Information is also given for the use of candidates for Certificates, &c., and thirty pages or so are devoted to questions which have been set at recent examinations.

"THE Practical Engineer, Electrical Pocket Book and Diary for 1929. Published in London by Humphrey Milford, 11, Warwick-square, E.C. 4. Price 2s. 6d.—In this year's issue, while all sections have been reviewed and brought up to date, particular attention has been devoted to Section XXI.—"Electric Photometry and Illumination"—and XXII.—"Electric Lamps." Both of these sections have been recast and largely rewritten with a view to emphasising, more strongly than had been done in previous issues, the practical aspect of illumination under modern conditions and requirements. It is pointed out in the preface that, by means of the tabulated room indices, coefficients of utilisation, &c., contained in Section XXI., a design for a lighting installation can be evolved in detail without the necessity of any calculation. The usual features are embodied in the book, including technical dictionaries in French, Spanish and Russian, and a buyers' guide.

"BRITISH Rainfall for 1927" is now issued by the Authority of the Meteorological Committee of the Air Ministry, and is published by H.M. Stationery Office, price 15s. net, and the present edition is the sixty-seventh annual volume of the British Rainfall Organisation. The volume, like its forerunners, is choke full of statistics. It contains a full account of the rainfall of the year under review, the total rainfall for the year at each of 4970 stations being placed on record. It is pointed out that in the year 1927 the rainfall over the British Isles as a whole was in excess of the average for the fifth successive year, and only four wetter years have occurred during the past sixty. Each summer month, except May, received more rain than the average. A separate article is devoted to snowfall in the British Isles during the half century 1876–1925, and special reference is made to the heavy snowfall at Christmas time, 1927. There are the usual diagrams and hosts of statistical tables.

"THE South and East African Year Book and Guide for 1929," which has recently been put upon the market, is published by Sampson Low, Marston and Co., Ltd., of London, price 2s. 6d., and were it only for the excellent series of sixty-four coloured maps which it contains, it might well be considered an exceedingly cheap production. It, however, embodies a great deal more than that. The volume is divided into three parts, which deal respectively with South Africa, East Africa, and Sport and Research. As a Gazeteer for Office use it claims, not without grounds, to be without rival, and its index contains more than 2000 place names. Imports and exports; means of transport; and communications are dealt with in much detail, and stress is laid on the rapid growth in manufactures, which is an important phase in recent South African development. While being intended for the information of the community at large, the volume contains much that is of particular interest to engineers, and, altogether, it is a most informative publication.

STEEL FAR OUTSTRIPS PIG IRON.*

ITS surprisingly high production of ingots has already had much attention in comment on the various contributions of 1928 to the steel industry. Noteworthy in that connection is the unprecedented "spread" between pig iron production this year and steel ingot production. Estimating pig iron at 38,000,000 tons and steel ingots at 50,000,000 tons, we have steel exceeding pig iron by no less than 12,000,000 tons. In the past ten years the difference has ranged between 2,680,000 tons in 1919 and 7,564,000 tons in 1926. In 1927 it was about 7,200,000 tons.

All along it has been known that steel companies were making a much larger use of scrap in the production of open-hearth steel, but it will no doubt be a surprise even to those who have closely watched this development to find that the pig iron ingot gap in 1928 has been nearly 4,500,000 tons more than in any other year.

It has been said for some years that pig iron is no longer a barometer of the steel trade, so large a place has scrap taken in steel making, with the remarkable expansion of the open hearth. Concurrently the increasing use of scrap in the blast-furnace has destroyed the parallelism that was once fairly uniform between pig iron production and Lake Superior iron ore production, Lake ores being 80 to 85 per cent. of the country's production of iron ore. Without now elaborating the subject, which has several points of interest to producers of iron ore and pig iron and to dealers in scrap, we append figures for 1928 and the year 1913, which is commonly taken in making comparisons with pre-war conditions. They represent production of Lake iron ore and the country's output of pig iron and steel ingots in the two years:—

	Lake ore. Gross tons.	Pig iron. Gross tons.	Steel ingots. Gross tons.
1913	52,377,362 ..	30,966,152 ..	30,280,130
1928	54,500,000 ..	38,000,000 ..	50,000,000

In 1913 steel ingot production was just overhauling pig iron production, which it passed in 1915. The figures are an impressive comment on much that was written twenty-five years ago of a doubling of pig iron production every ten years, and of an impending scarcity of Lake Superior ores in view of a ten-year doubling of demand for ore, to keep up with pig iron. With little more than a 2,000,000-ton gain in Lake ore output there is a pig iron increase equivalent to 14,000,000 tons of ore, and an ingot increase equivalent to more than 22,000,000 tons of pig iron. The steel industry has been drawing increasingly on its above-ground stores of raw material, as each year sends a larger tonnage to the discard. This and producer's "own" scrap now figure in our steel making economy to an extent never dreamed of by the prophets of an approaching famine in Lake ores.

* The *Iron Age*.

Institution of Mechanical Engineers.

NORTH-WESTERN BRANCH.

THE annual general meeting of the North-Western Branch of the Institution of Mechanical Engineers was held at the Engineers' Club, Albert-square, Manchester, on Thursday, December 20th, 1928, at 7.15 p.m., with Mr. H. L. Guy in the chair.

The following nominations for Committee were made:—Professor Dempster Smith, Mr. Kersey, Mr. Richardson, Mr. Ernest West, Mr. Newton, Mr. Hallam.

Professor Dempster Smith proposed that the Branch extend to the Institution an invitation to hold its summer meeting in Manchester during the coming year. The proposition was carried unanimously.

Mr. E. G. Herbert then presented his paper on "Machinability," and a discussion took place.

The Chairman (Mr. H. L. Guy) said Mr. Herbert's discovery that machinability might be assessed in terms of the hardness of the chip was one which might lead to increases in knowledge of one of the most complicated and yet the commonest of engineering operations—that of cutting metals. He (Mr. Guy) had been interested in what Mr. Herbert had put before them as to the function of the built-up edge on tools, because it explained a phenomenon which he had come across once in quite a remote connection. In steam turbines, the shaft passed from places where there was steam of considerable pressure into the open atmosphere.. The escape of the steam was retarded by the use of a built-up edge. They had once made extensive experiments in that connection. The labyrinth had been made out of a small strip of material about 1/20000 or 1/30000 inch thick. Everything had gone well until they had used nickel. After the machine had been run it had given no external evidence that anything was happening inside, but it had been discovered that a perfectly drawn radius of 1in. diameter had been removed from the shaft immediately opposite to the labyrinth. The nickel had the property of attaching to itself just such a chip to start building up a cutting edge which in the end was sufficient to groove out a semi-circle of 1in. diameter. Mr. Guy said he would like to ask Mr. Herbert whether, in the course of his researches, he had arrived at any conclusion at to whether any, and, if so, what property of the material was called into play in forming that cutting edge, apart from the shape of the tool itself?

Mr. J. Newton said that he would like to know if the author could give them some clear indication of the physical property which was meant by machinability. He would also like to ask Mr. Herbert if he had not missed out an important thing in the durability of the tool. In the very voluminous researches of White on cutting tools, he had laid down as a test of a tool the speed and depth and speed of cut which would destroy its edge in twenty minutes. The subject was so complicated that Mr. Newton said he would hesitate to make any general assertion on the action of a cutting tool. One thing which he believed was true Mr. Herbert had already contradicted in anticipation when he said that a tool would last a shorter time at very low cutting speeds than at high cutting speeds. He thought the experience of the workshop indicated that when a man in a workshop was cutting, as he was always apt to do, at high speeds, the increase in speed did shorten the life of the tool, and the life of the tool was a very important thing in the case of ordinary lathe work. It might be necessary to change the tool every hour. In the case of milling operations, it would probably be necessary to change the tool once a day. In gear cutting, he had had a cut which had had to remain perfectly accurate for 174 hours continuous cutting. Had he chosen too high a speed of cutting, he would have ruined the tool and possibly the work. In the case of a shearing machine, he had known tools last from four to six weeks. The operation of the tool was a very important element in that problem.

Mr. R. W. Bailey said that Mr. Herbert had pointed out that the hardness with which the tool had to deal in the material was not the hardness of the material at normal temperatures. There was, however, another thing which needed to be taken into account, and that was that the hardness of the metal at the temperature at which it was being operated was probably not the hardness which was measured under atmospheric temperature. If one took as the basis of machinability that it was the hardening of the material, then surely that hardening which occurred owing to the deformation of the material was expressed by the work which was being done in forming the material. He would like to ask, therefore, whether one would be correct in saying that the law of machinability was the force which the tool had to apply, or the energy which the work absorbed in machining.

Mr. Daniel Adamson said that one outstanding feature of the paper was the honourable position accorded to the built-up edge. He added that that had been the first thing he had learned from the foreman turner when he was a boy in the shop. Then had come the high speed tool steel experiments under Dr. Nicolson, and they had again found the built-up edge on the high-speed steels. The conclusion arrived at had been that, so long as that built-up edge remained, they could get a long life out of the tool. Their theory was that gradually the cutting tool wore away the background of the built-up edge until eventually the tool failed suddenly. The built-up edge had been known as many as fifty years ago, and now again Mr. Herbert had given it a place almost in the classics.

Mr. J. S. G. Primrose said that perhaps he might be permitted to offer another aspect for the consideration of the meeting, and that was that Mr. Herbert had clearly shown them an application of the microscope in engineering. The researches which Mr. Herbert had undertaken could not have been brought to their admirable conclusion without the aid of a microscope, and he thought that Mr. Herbert might have gone a step further, as some of his photographs did, although he had not drawn attention to it, and showed that the machinability of the metal depended, not on the hardness, but on the constitution of the metal. It was shown quite clearly in the cases he had mentioned of the annealing of normalised steels. That brought them to the fact that the words "hard" and "soft" might quite well be reversed in the workshop and in the laboratory. It was the constitution which made for easy or difficult machining. Constitution was a most important thing in machinability. The researches of Mr. Herbert had clearly proved that the best tool was not the one which cut itself, but which got the material it was cutting to help it out in its own job. They had therefore to try and arrange to put the steel into the condition which would most readily favour the building up of that little particle which pushed the other bit off. They were really shearing the metal, and not cutting it, by something which was not the tool but an advance guard.

Mr. Herbert, in replying, said, with regard to Mr. Guy's remarks, that he could imagine that there might be an affinity between certain metals which would cause them to weld very rapidly. Particularly in turning aluminium, there was almost a chemical action going on between the point of the tool and the aluminium it was turning, and it became very firmly attached. More a fusing than a welding appeared to take place, although no high temperature was involved.

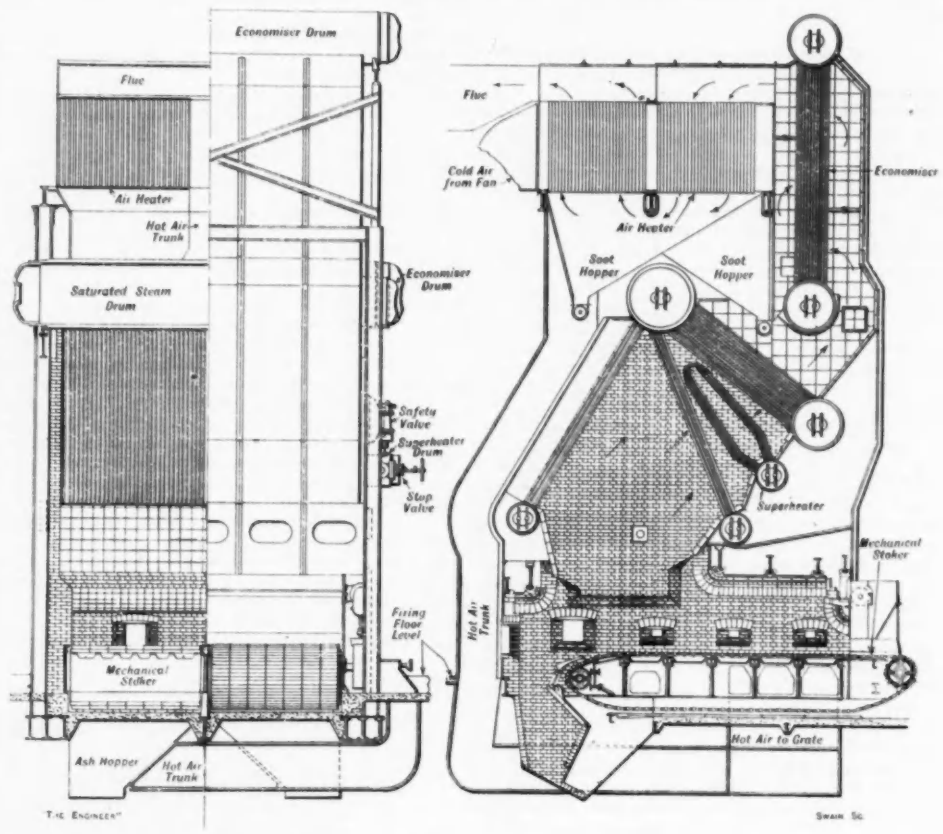
Mr. Newton had tried to drag him into defining machinability. People were wise to keep away from those definitions, and he was not prepared to define machinability.

Mr. Bailey had brought out a point which he had expected, as to the effect of temperature on the hardening. He did not know what Mr. Bailey had in mind—which effect of temperature. A chip might be heated, and it was very easily deformed, so that might affect the hardness at which one was cutting. That could not occur under his conditions, however, because it had been very amply flooded with water, and the chip could not have got red hot, and certainly not hot enough to be affected in its ductility. There was another temperature effect which was highly important, and that was that if a work-hardened metal were deformed and then put up to quite a moderate temperature, its hardness would be increased. That was a very important effect which was being investigated and turned to practical use both in England and America.

He hoped that Mr. Adamson did not think that he was claiming to be the inventor of the built-up edge. He had watched the Manchester experiments very closely, and he was acquainted with Dr. Nicolson's results. They were his first insight as to what happened at the point of the tool. He gave full credit to Dr. Nicolson for his very interesting pioneer work on that subject. Mr. Adamson's suggestion that that steel, 16BB, had been so difficult to cut because there had been no built-up edge, was one which he could not accept. The explanation was given in the comparison of the work-hardening figures. The machinability followed the work-hardening capacity, and not the original hardness, as one would expect. He quite agreed with Mr. Primrose in what he said about the constitution of the metal. It was very important, and so was its chemical constitution or its physical constitution.

600 LB. PRESSURE WATER-TUBE BOILER

YARROW AND CO., LTD., SCOTSTOUN, ENGINEERS



A 600 lb. Pressure Water-tube Boiler for Industrial Use.

IN THE ENGINEER of September 21st we illustrated and described a 350 lb. pressure Yarrow water-tube boiler of the marine type, one of the five boilers installed in the new P. and O. turbo-electric liner "Viceroy of India," which is now nearing completion at the yard of Alexander Stephen and Sons, Ltd., of Linthouse, Glasgow. In what follows we give an account of one of two high-pressure boilers for the Castner-Kellner Alkali Company, Runcorn, a subsidiary company of the Imperial Chemical Industries, Ltd., which have recently been supplied and set to work by Yarrow and Co., Ltd. The boilers, which have a working pressure of 600 lb. per square inch, are probably among the largest, if not the largest, high-pressure boiler plant of this capacity now in commercial operation in this country.

Each unit, as will be seen from the accompanying illustration, comprises a water-tube boiler with its superheater, economiser and air heater. The design and lay-out was specially drawn up to suit an existing boiler-house and flues which had been prepared for extension with another type of boiler. The neat lay-out obtained was made possible by the very elastic nature of the Yarrow design, which enables the overall dimensions of the boiler to be varied within fairly wide limits. For this particular installation stoker firing was adopted, as being most suitable for the conditions obtaining at the works, and both forced and induced draught fans are fitted. Yarrow and Co., Ltd., acted as the main contractors and they constructed all the plant with the exception of the stokers and fans. The stokers are of the Underfeed Stoker Company's latest "L" class type and each boiler has a stoker with a width of 17ft. 6in. and a length of 18ft. 6in., while the fans were supplied by Davidson and Co., Ltd., of Belfast.

As shown by the drawing, the boiler is of the latest single-flow type, enabling the gases to traverse large nests of tubes at the front, while the rear bank of tubes acts as a screen absorbing only radiant heat. The combustion chamber has a very large capacity and an outstanding feature of the design is the large amount of heating surface exposed to the furnace.

It will be seen that the superheater, which is of the Yarrow self-draining type, has steeply inclined tubes, and with its large integral steam drum is so placed between the nests of boiler tubes that the steam temperature fluctuates only slightly with variations of load.

As the gases leave the boiler they pass around the vertical tubes of the economiser, which is provided with movable deflectors so as to avoid lodgment of soot. Finally they flow through the tubes of an air heater which is constructed in two sections, the first gas pass being in a downward and the second in an upward direction. Finally the flue gases are discharged into a common main flue which had been provided previously near to the roof of the building at the back of the boiler.

The principal particulars and the designed performance of each of the two boilers supplied are as follows:—

Generating heating surface	10,500 square feet
Superheater heating surface	3250 square feet
Economiser heating surface	5500 square feet
Air heater heating surface	12,000 square feet
Grate area	324 square feet
Normal evaporation	61,500 lb. per hour
Overload evaporation	75,000 lb. per hour
Pressure	600 lb. per sq. in.
Steam temperature	780 deg. Fah.
Feed temperature	225 deg. Fah.
Overall efficiency	86 per cent.

The above outputs are calculated on a heating value of 10,000 B.Th.U. for the coal. The first of these two boilers has now been at work for some months, while the second was completed a few weeks ago, and both of the boilers have been run continually day and night over long periods.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Improved Market Tone.

LAST week's quarterly meeting in Birmingham has heartened Midland producers of iron and steel and raised their spirits, but so far it has failed to increase order books materially, consumers persisting in their attitude of refraining from placing large forward contracts, and relying upon orders for small tonnages given out as the material is required. Even the firmer attitude of producers with regard to prices failed to shake them. However, though order books are not bulky, there is every indication that there will be a good and free flow of orders, sufficient, it is believed, to keep producing works engaged at present capacity even if not necessitating increased output. In the raw iron department there is a marked improvement in inquiries, while heavy steel specifications this week have also been better. The sheet mills are very well placed, but there is ample room for improvement in the finished iron branch of the market. The first month in the year is generally a quiet one in Midland industrial circles, so far as new business is concerned, but February should produce an augmentation of orders. There is undoubtedly a slight improvement in the heavy industries of this area, and the market tone is accordingly brighter.

Pig Iron Prices.

It is pleasant to be able to record a revival in buying of pig iron in the Midland market. Business has been so dull of recent months that blast-furnacemen were almost in despair, and they are cheered and encouraged by the improved inquiry which has been in evidence since the quarterly meeting. It must not be assumed there is a good demand, for that is far from being the case, business is too patchy and buyers too cautious, but there is, without doubt, an improvement on recent buying, and orders are placed on a somewhat larger scale. Smelters hope for further development to enable them to increase their present rate of production. How far smelters by their firm attitude towards selling prices have themselves contributed to the market improvement is problematical, but consumers were evidently impressed by the withdrawal of the offers of supplies at recent minimum rates, and the attempt of some producers to advance recent maximum rates. It was evident by inquiries made on 'Change in Birmingham to-day that the chance of doing business in Derbyshire No. 3 foundry pig at £2 19s. has passed. Makers were firm in their demands for £3 as a minimum, some smelters asking 6d. and 1s. more. Derbyshire forge was very scarce and none could be heard of at £2 15s., but there were some small transactions at £2 16s. and £2 17s. Northants pig was steady at the prices previously ruling, but there was a tendency to withdraw the £2 15s. quotation for No. 3 foundry, leaving the higher figure of £2 16s. as the market level. The furnaces which are doing the most business at the moment and which are likely to continue to do so are those which have scrapped old plant and installed new. Economies in production have been effected, enabling bigger output to be made, and lower prices are charged for the metal. This explains the success of some Midland firms in competing in Cleveland and Scotland. Foundrymen in Staffordshire are generally only moderately employed, but a few of them are comparatively well off for business, and these are inclined to order iron in slightly heavier quantities than of late. At the forges work is light, and forgemen hesitate to buy except for current needs. In this branch of industry, however, prospects are considered to have become slightly more hopeful since the New Year set in.

Steel Demand.

There is some awakening of interest in heavy steel, and inquiries this week have been of a more generous nature. There is little evidence of big scale business, but mechanical and structural engineers speak of the early materialising of recent tenders, and of the material they will require to carry out the contracts. A good demand for steel plates and sections is anticipated in the immediate future from rolling stock firms, who have booked good contracts for overseas. The improvement in the shipyards should also have a beneficial effect, while the activity in the motor engineering industry in the Midlands is again to the good of the steel trade. No change has been made in finished steel prices. Angles and joists remain at £7 17s. 6d.; tees, £8 17s. 6d.; and plates at £8 12s. 6d., less rebate. Staffordshire hoops are £10 at works. In the half-products department local makers continue to hold their own, nor have they much need to fear foreign competition while the present relation of prices persists. Importation into this area is said to have declined considerably. Continental makers show little eagerness to cultivate this market, but there are signs that Germany is open to do business in semi-finished steel. German billets were on offer in Birmingham this week at about £6 1s. for 2in. and £5 17s. 6d. for 2¼in. French and Belgian billets were unobtainable. Native makers though holding their own with the foreigner have been compelled to ease their quotations slightly on account of some slackening of consumptive demand. They offered billets this week at prices varying from £6 2s. 6d. to £6 5s.

Staffordshire Bar Iron.

Staffordshire makers of best grade bars report moderately good business as a result of last week's quarterly meeting. The maintaining of the basis for marked bars at £12 per ton gave confidence to consumers who placed orders with some regard to future requirements. This high quality iron is in demand for railway material, and exacting engineering work, and there is a considerable probability that a big call for it will be experienced during the current year. The marked bar mills are running regularly and have a fair margin of orders on their books. In Crown iron, activity is not so good, and the local prices are subject to competition from Lancashire and Derbyshire, while the transport rates to the port make export sales a difficult proposition. Local makers want £9 15s. to £10 for their bars, but they can be procured from outside sources at as low as £9 2s. 6d. Advance orders are being given out for chain and cable iron which will be required later in connection with ships that have been put in hand. Thus far, however, this district has not had much work from the shipyards. Nut and bolt bars are slow of sale. The trade in this class of material is only a remnant of what it was years ago, steel and continental material having taken its place in this district. Belgian No. 3 iron is on offer at date at £7 2s. 6d. delivered against the lowest Staffordshire figure of £8 10s. Not all local makers are prepared to accept this figure, which they contend, taking into account the low turnover to which they have been reduced, does not show a profit. There is an increased demand for wrought iron gas tube strip, the lowering of the selling price to £10 12s. 6d. having acted as an incentive to consumers to place orders.

Galvanised Sheets.

Makers of galvanised sheets are in a strong position, and except for a few firms, have sold their production to March. Demand continues good, and some recent buying on account of South America has helped to stimulate overseas trade. Prices of 24-gauge corrugated sheets are firm at a minimum of £13 10s., rising in some cases to £13 15s. per ton. The call for black sheets is also steady and strong, and recent values are maintained.

Tin-plates.

There is only a poor demand at the moment in this district for tin-plates and Welsh makers who attended last week's quarterly meeting in Birmingham in quest of orders had only moderate success. They asserted there was a possibility, amounting to probability, of an increase in the existing basis of 18s. within a fortnight, but the announcement failed to stir local consumers. There was no increase in the desire to secure supplies this week, and specifications were the exception rather than the rule.

Production Figures.

Ironmasters in the Midlands regret to hear of the fall in the production of pig iron during December last. It had been hoped that the previous month's total, at any rate, would have been upheld. They note the decrease of three in the number of active furnaces, bringing the total in operation at the end of the year to 132, and trust that ere long some of the eight blast-furnaces which were blown out in December will be re-commissioned. The production of pig iron in December amounted to 540,400 tons, compared with 544,400 tons in November and 559,100 tons in December, 1917. It included 170,300 tons of hematite, 219,600 tons of basic, 114,200 tons of foundry, and 14,500 tons of forge pig iron. Production of steel ingots and castings in December amounted to 683,100 tons, compared with 762,500 tons in November, and 604,900 tons in December, 1927. The December production brings the total production for the year up to 6,611,300 tons of pig iron and 8,525,100 tons of steel ingots and castings, compared with 7,292,900 tons and 9,097,100 tons respectively in 1927.

Motor Vehicle Production.

The majority of the Midland motor engineering firms, particularly those manufacturing commercial vehicles, continue to receive a steady flow of orders for both the home and export markets, and prospects are decidedly good. Guy Motors, Ltd., of Wolverhampton, is doing very well, orders for transport vehicles continuing to be received. It has recently been awarded repeat orders from Northampton Corporation for ten six-wheeled double-deck omnibus chassis, and from Harrods, Ltd., for twelve 25 cwt. chassis; and an order from the National Omnibus Company, Ltd., Chelmsford, for a number of 20-seater omnibus chassis and 28-seater promenade runabouts.

Electrical Engineering.

Electrical engineers in this district have a substantial volume of business in hand, and everything points to an even busier year than was the case in 1928. Practically all the works are making full time. Makers of all kinds of electrical apparatus and heating and lighting fittings are also extremely well placed for orders, which continue steadily to come in.

A Year's Trading.

Industrialists here note with satisfaction that imports of iron and steel last year fell far short of those of the previous twelve months. For the year 1928 the quantity imported was 2,895,927 tons, valued at £24,158,492, compared with 4,406,089 tons, and £34,032,026 in the preceding year. Unfortunately exports of iron and steel goods also declined, the loss in value from the previous year being £2,581,856. Exports of manufactured goods provided a happy feature, the value of the exports in the vehicles group going up from £35,414,273 in 1927 to £46,965,401 last year, and machinery from £49,920,843 to £53,749,131.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

For Further Inquiry.

THE report of the Home Office Inspector on the official inquiry into the causes of the accident which occurred in August, 1927, at the Bradford-road gasworks of the Manchester Corporation, and the comments on that report issued by the Gas Committee, are not to be the end of the matter. There is apparently a strong body of opinion that the position is far from satisfactory, and under pressure at the last meeting of the City Council, the members of the Gas Committee accepted a proposal "that the report of the Gas Committee be not accepted, and that a special committee be appointed to consider and report fully on the findings of the Home Office Inspector." On Monday of the present week the Nominations Committee appointed nine members of the City Council to serve on the special committee. It was alleged at last week's Council meeting that the reply of the Gas Committee to the Home Office report was "a mere distortion of the evidence offered at the inquiry and of paragraphs selected from the Home Office report," and, further, that the Committee's reply "went to strengthen the demand for a first-class engineer to take charge of the undertaking."

Lathe Tools Research.

A step that will be welcomed by many engineers is the issue by the Manchester Association of Engineers of a summarised version of the results of an investigation carried out by the Lathe Tools Research Committee of the Association, with financial assistance from the Department of Scientific and Industrial Research, to determine the cutting capabilities of high-speed tools of the type commonly used on turning lathes for roughing cuts. The summary takes the form of a 24-page booklet, containing five chapters, concerned respectively with tool steel and heat treatment, cutting speeds for mild and medium steels, cutting speeds for cast iron, forces to which tools are subjected when cutting medium steel and ordinary cast iron, and power consumed in cutting medium steel and ordinary cast iron. In a foreword, the Research Committee explains that the results of the tests have been rearranged in the summary to facilitate their application to workshop practice.

Air Port Developments.

With a view to securing official sanction to certain modifications in the requirements of the Air Ministry in order to reduce the cost of constructing the proposed municipal aerodrome at Chat Moss, the special Aerodrome Committee of the Manchester Corporation is to meet an official of the Ministry here this week. The Committee hopes to be able to ask the City Council next month to proceed with the scheme. It is now reported that, as soon as the work of construction is completed, a company will be formed to take over the running of the aerodrome. Meanwhile, preliminary steps of a practical nature with a similar object in view are being taken in other parts of Lancashire. Apart from Liverpool, where the customary rivalry to Manchester is being displayed, the Borough Surveyor of Warrington, following a communication from the Air Ministry, has been instructed to report on suitable sites within the borough, and in East Lancashire action in a similar direction is being taken jointly by the local authorities of the two adjoining towns of Nelson and Colne.

The Mersey Tunnel.

It is expected that tenders will be invited shortly for Contract 4 in connection with the river Mersey tunnel construction scheme between Liverpool and Birkenhead. This section of the work comprises the construction of the full-sized tunnels on the Liverpool side from George's Dock shaft to the Old Haymarket and New Quay. In succession to the late Sir Archibald Salvidge, Sir Thomas White has been appointed Chairman of the Mersey Tunnel Joint Committee.

Warrington's Water Supply Scheme.

Warrington Corporation has been empowered to promote a parliamentary Bill to construct waterworks and to take water from the river Mersey for trade purposes, the estimated total cost of the scheme being £59,000.

Dismantling a Wagon Works.

Thos. W. Ward, Ltd., Sheffield, who some time ago purchased the buildings and plant of the well-known Ashbury's Wagon Works at Openshaw, Manchester, and have since sold the buildings to the London and North-Eastern Railway Company, are busy dismantling the surplus plant with a view to the railway company securing early possession. It is reported that the latter, after the necessary work of reconstruction has been carried out, will for the time being use the works as a repair shop for motors and wagons, and also as a goods centre.

Lancashire Motor Boat Service.

As the outcome of a meeting in Manchester during the past few days, it is proposed to form a private company for the purpose of starting a fast motor boat service between Blackpool and Lytham, and also between Southport and Preston, using Thornycroft boats of a special type.

A New Landing-stage.

The floating landing-stage at Egremont Ferry, on the Cheshire side of the river Mersey, is to be replaced in May by a new structure at a cost of £28,000.

Work for Birkenhead Yard.

An order for a new cargo steamer to be ready for service next June has been placed with Cammell Laird and Co., Ltd., Birkenhead, by the Isle of Man Steam Packet Company.

Metal Window Frames for America.

Williams and Williams, Ltd., Chester, has secured an order for the supply of 3500 metal window and door frames, at a cost of £22,000, to be used in the construction of a twenty-storey "apartment house" in New York.

Non-ferrous Metals.

A certain amount of weakness, though in no instance pronounced, has been in evidence in all sections of the non-ferrous metals, except copper, during the past week. So far as copper is concerned, buying interest in

the metal is no less keen than it has been during the progress of the recent rise, and at the close of business last week-end a rather substantial advance in prices had occurred. Tin has reacted again after its slight rise, and the outlook in this section is not too clear. Certainly, if one may judge from the increase in the stocks of the metal in this country, the statistical position is by no means in favour of the "bulls." In consequence, buyers are showing some nervousness, and the actual buying movement has not been active. Lead has lost the ground gained a week ago, although there is a fair weight of business in the metal being done, and the undertone at the moment is reasonably steady. Less optimistic news regarding the success of the output control proposals is having its influence on spelter prices, and after a remarkably firm spell since late in November values, for the second week in succession, are lower to the extent of a further 10s. per ton.

Iron and Steel.

In no branch of the iron and steel markets locally has there been indication of much actual improvement in conditions, but there is an undoubted feeling of hopefulness which is almost general. The movement of pig iron is on fairly satisfactory lines, with, except for occasional complaints of poor specifications, good contract deliveries going. Only in a few instances, however, have new contract orders for any important tonnage been placed. Quotations are very firm at about 68s. per ton for Staffordshire, delivered locally, from 68s. to 68s. 6d. for Derbyshire, 79s. for Middlesbrough, 87s. 6d. to 90s. for Scottish, and 82s. for hematite. There is a quiet call for constructional steel materials, principally on early delivery account, with some inquiry for locomotive boiler plates, and a moderate demand for small bars, prices all round being well held at recent levels. After a slight spurt in the volume of inquiry a week ago, the market for continental steel has relapsed into a comparatively quiet condition, though makers on the Continent are in a positon to maintain quotations on the strength of satisfactory orders from other markets. For delivery to Lancashire works, imported angles are at about £6 15s. per ton, wire rods at £7, joists at £6 5s., steel bars at £7 5s., sheet bars at £5 16s., and bar iron at about £7.

BARROW-IN-FURNESS.

Hematite.

The condition of the hematite pig iron trade continues to be satisfactory, and there is still a tendency on the part of customers to ensure future supplies by placing orders for forward delivery. This is a good sign, for it is evidence that buyers need iron for more than their immediate requirements. There is more confidence in the market and makers are clearing their productions. In view of local steel requirements there is no chance of iron stocks accumulating. Trade with the Continent is fair, and there is a call for special qualities. As evidence of the better state of the market, one need only refer to the prices, which are now showing a tendency to harden. There is a steady call for local iron ore and outside business is showing an improvement. Foreign ores are in moderate, but steady, demand. In the steel trade there is not much activity, and there is keen competition for any orders which come into the market. The local works are active at present, but if they are to be employed continuously more orders are needed.

Shipbuilding.

There were launched from the yard of Vickers-Armstrongs on Tuesday two submarines for the Chilian Navy. It is unusual for two vessels to be launched on the same day, but on this occasion there has been a certain amount of concentration on the work with a view to facilitating delivery. A large number of Chilian guests were present at the ceremonies, which were separate.

SHEFFIELD.

(From our own Correspondent.)

Progressing Slowly.

THERE is little sign of improvement in the Sheffield trades so far, although the year has opened with a fair amount of confidence in the future. Sheffield is generally later than other centres in feeling the effect of great fluctuations, so that the absence of revival so far is not necessarily a cause for pessimism. There are certainly improvements on the North-East Coast, in Scotland, and elsewhere, and it is believed that these are sure to be reflected in Sheffield sooner or later. At the moment, while the soft basic steel department maintains its activity, the acid side of open-hearth production remains dull. Tonnage orders in the latter branch are few, and makers of finished steel products have not much work on order. The home railways are not yet placing any great weight of work in axles, tires, or springs, though they are sending out a fair number of orders of small dimensions. The amount of railway work on hand for overseas is considerable. The market for basic steel scrap has lately shown increased strength, and the material is now worth 59s. to 60s. per ton locally.

Large Firm's Rating Appeals.

The difficulties which the heavy steel trade is having to face at the present time were brought to public notice at the Sheffield Quarter Sessions last week, when two of the largest firms appealed against their assessments for local rates. Only one case was gone into—that of Cammell Laird and Co., Ltd., who asked for a reduction of their assessment of £27,000. Their grounds of appeal were, in general, the depressed condition of the heavy trades, and, in particular, the virtual closing of their armour-plate department, which has been seriously affected by the Washington Agreement. It was stated that, whereas the pre-war production of armour-plate was from 10,000 to 12,000 tons annually, the amount made since April, 1928—that is, in the current financial year—was only 137 tons. It was also pointed out that there was no likelihood of the department being substantially employed until 1931, at all events. Counsel also stated that the up-to-date foundry which the company opened a few years ago, in the hope of making up its losses on armour-plate, was itself being run at a substantial loss. The old assessment of the armour-plate department had been reduced by two-thirds, but the Recorder did not consider this sufficient, and granted a further reduction of £2000. In respect of the other departments of the works, he upheld the assessment. John Brown and Co., Ltd., had entered a similar appeal, and in their case a similar order was made by consent. The appellants were not allowed costs.

Railway Developments.

The transport facilities of the Nottinghamshire coal area are being considerably increased by a scheme which the London, Midland and Scottish Railway Company is carrying out, at a total cost of £200,000. One section of the work, already completed, is a loop line at Kirklington; another, which has just been brought into operation, is a branch line to Welbeck Colliery, constructed at a cost of £60,000. The branch is from 3 to 4 miles long, and, leaving the Mansfield and Worksop line at a point about ¼ mile north of Shirebrook Station, affords direct access to the colliery. Near Shirebrook, a new marshalling depôt is to be provided, for the sorting and despatch of traffic from various collieries in the district. Other work to be carried out includes the doubling of the line between Upton Crossing and Rolleston West Junction; additional accommodation at Mansfield Colliery sidings and Rufford Colliery sidings; extension of a loop at Farnsfield; and the provision of a new West Curve at Rolleston, connecting the Mansfield and Southwell line with the Lincoln and Nottingham line. In connection with the recent transport development which enables railway companies to share in operating road services, the London and North-Eastern Railway Company has purchased from Thos. W. Ward, Ltd., of Sheffield, the site of Ashbury's Wagon Works, Openshaw, Manchester, together with buildings, properties and equipment applicable to its scheme. The site covers 20 acres, with sidings and connections to Ashbury Station. One of the buildings in the extensive range of shopping is a very fine steel structure, measuring 680ft. long by 108ft. wide. As the railway company requires early possession, Messrs. Ward are dismantling the surplus plant as speedily as possible.

Cutlery and Plate.

There was no general resumption of activity in the cutlery and plate trades until the present week. Only a moderate amount of work is on hand, and the first month of the year promises to be a very quiet one. The returns of trade with the United States show that the value of cutlery exported to that country last year was £89,000, as compared with £74,000 in 1927. Included in the total was £36,000 for safety razors and blades and £25,000 for the blanks of safety blades. The British Army Department is inviting tenders for 100,000 all-steel table knives, 85,000 nickel silver spoons, 87,000 nickel silver forks, 4500 carving knives, 2600 carving forks, and 2000 cook's knives. The Admiralty requires 12,000 clasp knives, the scales of which, instead of being of horn as heretofore, are to be of duralumin. Progress is being made with the alteration of grinding shops and the installation of abrasive wheels. A Sheffield grinder, Mr. S. Peace, has invented an appliance for improving the conditions of grinding, a demonstration of which was given at the works of Joseph Cam and Sons, Ltd., on Sunday morning, in the presence of many representatives of the trade. One of the advantages of the invention is that the water used on the stone, instead of being scattered about, is sucked into the top and runs down into the trough without any splashing: another is that the heavy dust is carried with it, leaving the atmosphere clear, while the light dust goes up into a hood, and is carried away by a natural draught caused by the revolution of the stone. The Sheffield Grinders' Joint Council has passed a resolution declaring itself convinced of the usefulness of the appliance.

Steel Works Changes Hands.

It is announced that Thos. W. Ward, Ltd., of Sheffield, has acquired from the receiver the Carbrook Steel Works, Sheffield, an old-established concern which became a limited company in 1909. In addition to the steel furnaces, the plant consists of three bar mills, with forge and five steam hammers. A special production has been hollow-cored mining drill steel. The acquisition is presumably for dismantling purposes, though it is yet early to determine the fate of the works, as certain propositions are being considered which may result in the running of part if not the whole of them.

A Safeguarding Ballot.

A step of exceptional interest has been taken by the Sheffield Chamber of Commerce in sending to all its members a ballot paper asking them to reply "Yes" or "No" to the question, "Are you in favour of the principle of the extension of Safeguarding to the iron and steel industries?" There has been considerable, and occasionally rather strenuous controversy within the Chamber over this question. There are members who are politically Protectionists and others who are no less ardent Free Traders, but the majority have expressed no definite view either way. The ballot is to be secret, but those replying are asked to state the nature of their own business or profession, the object being to see how far other industries and other interests are prepared to support—or otherwise—the demands of those engaged in the iron and steel industries for safeguarding.

Aviation Progress.

Active steps for the promotion of aviation, municipal and otherwise, are being taken at a number of centres in Yorkshire. There is a keen desire in Hull that that city should become an important commercial air port, and a meeting of commercial men and others interested in civil aviation has passed a resolution recommending the City Council to purchase Hedon Racecourse, a site covering 200 acres, as a landing place for aeroplanes. At Sheffield, Colonel A. E. Edwards, who was lately associated with the Air Ministry and is now managing director of National Flying Services, Ltd., has made an inspection of several sites. It is understood that his company is prepared, assuming that a satisfactory site can be found in the district, to provide hangars and other buildings, and to afford facilities for a local flying club, provided that a satisfactory number of members can be secured. Colonel Edwards is reported to have been satisfied that at least two of the sites which he inspected, one on the north side of Sheffield and the other on the south, would make excellent aerodromes. A flying club has been launched in Sheffield, and has now about 150 members.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

BUSINESS in the Cleveland pig iron trade is showing a tendency towards expansion, and the tone of the market continues to be favourable. Orders that were held up in December are gradually being released. Home requirements are larger, and indications of an increase in the export demand are noticeable. Some uncertainty is felt concerning early price movements of foreign pig iron, but at the moment Cleveland makers are holding their own in the immediate area, though Midland iron continues to go to Scotland at comparatively low figures. Stocks of Cleveland pig iron are still low, and makers are easily able to dispose of the bulk of their output. Conditions at present afford hope that the recent improvement will be steadily maintained. Prices are firm, No. 1 Cleveland foundry iron being 68s. 6d.; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; and No. 4 forge, 54s. 6d.

Hematite Pig Iron.

While the volume of new business passing in the East Coast hematite pig iron trade at the moment is not large, an expanding tendency is discernible. Stocks all round are exceedingly low, and the slightly accelerated rate of production does no more than keep pace with the demand. Terms on which business is put through vary a little, but the basis may be given at about 71s. for ordinary qualities.

Ironmaking Materials.

Consumers of foreign ore are as disinclined as ever to negotiate for renewal of contracts at about the figures named by merchants, who, however, maintain that values are more likely to advance than otherwise. For best Rubio ore the quotation is 22s. 6d. c.i.f. Tees. There has been a little more business passing in blast-furnace coke, but ironmasters still hesitate to buy extensively. Good average qualities keep at 17s. 6d. to 17s. 9d. delivered to works in this area.

Manufactured Iron and Steel.

There has been some expansion of demand in the manufactured iron and steel trade during the past few days, and the general position is very encouraging. The productive capacity available could handle a heavier tonnage, but in several departments a very large amount of work is being carried out. In sections that cater for shipbuilding there is prospect of much activity. The continued busy employment of railway material plant is assured, while machinery turning out all kinds of sheets will be kept running at almost full capacity over the first quarter of the year on contracts already secured. Values of all descriptions of finished iron and steel are steady.

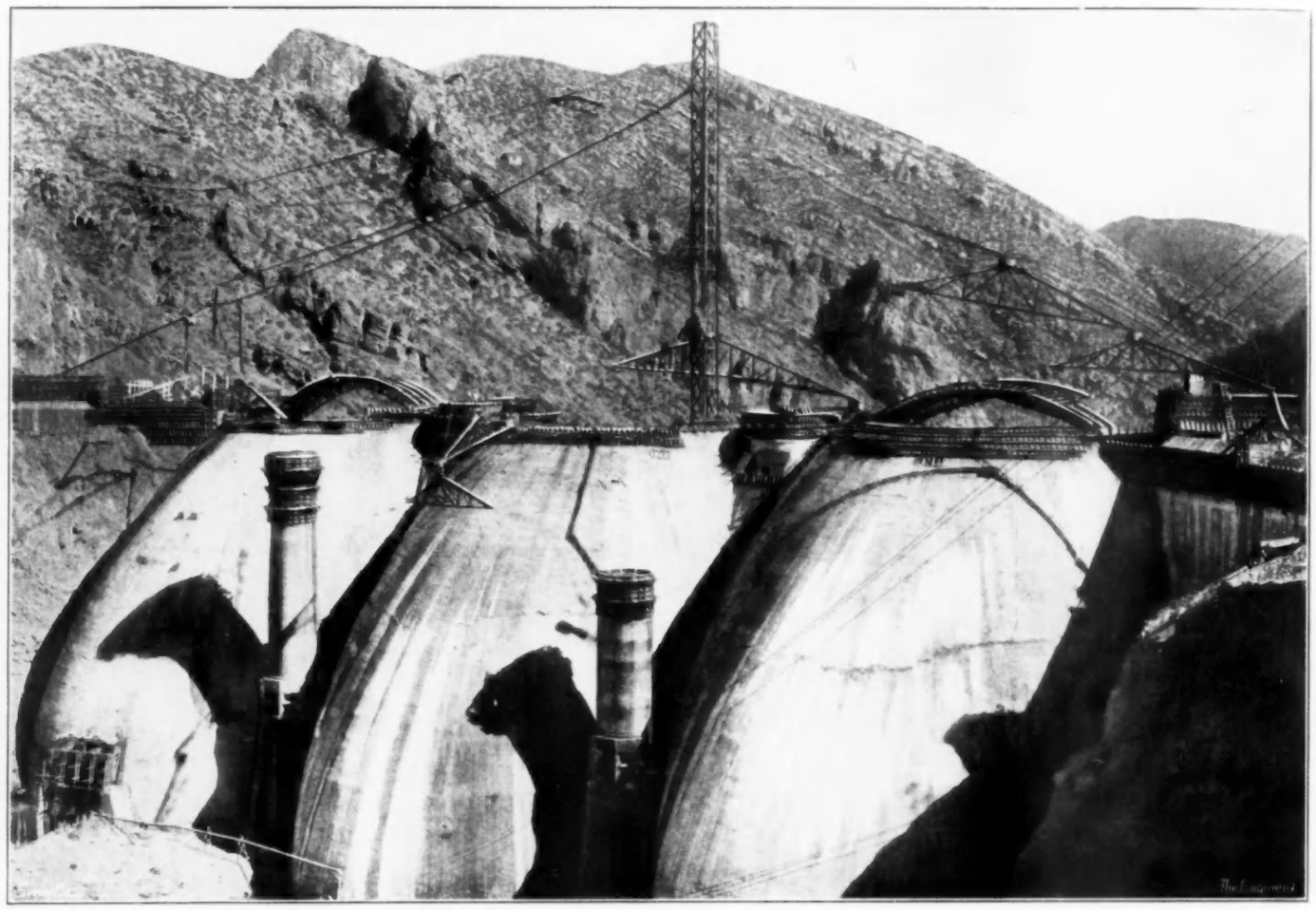
More Shipbuilding Orders.

It is announced that Palmers Shipbuilding and Iron Company, Ltd., Jarrow and Hebburn, has booked a further order for a motor ship of 16,000 tons deadweight for H. E. Moss and Co., Ltd., Liverpool, the first vessel having been ordered two or three weeks ago. The vessel will be fitted with Wallsend Sulzer oil engines, supplied by the Wallsend Slipway and Engineering Company, Ltd. This order increases to five the number of vessels which the Palmer Company has recently booked. William Doxford and Sons, Ltd., of Pallion, Sunderland, have secured an order for two motor ships for Sir William Reardon, Smith and Sons, Ltd., of Cardiff and London. Last year the firm built for the same owners the "East Lynn," a motor vessel of 4655 tons, to carry about 8500 tons on a moderate draught with a speed under loaded conditions of 10½ knots. The newly ordered vessels will be both larger and faster than the "East Lynn." During the past three months orders for new vessels have been freely placed with North-East Coast builders, but a lull has now occurred. It is understood, however, that several inquiries are still circulating for new tonnage, and that the prospect of further orders being given out is hopeful.

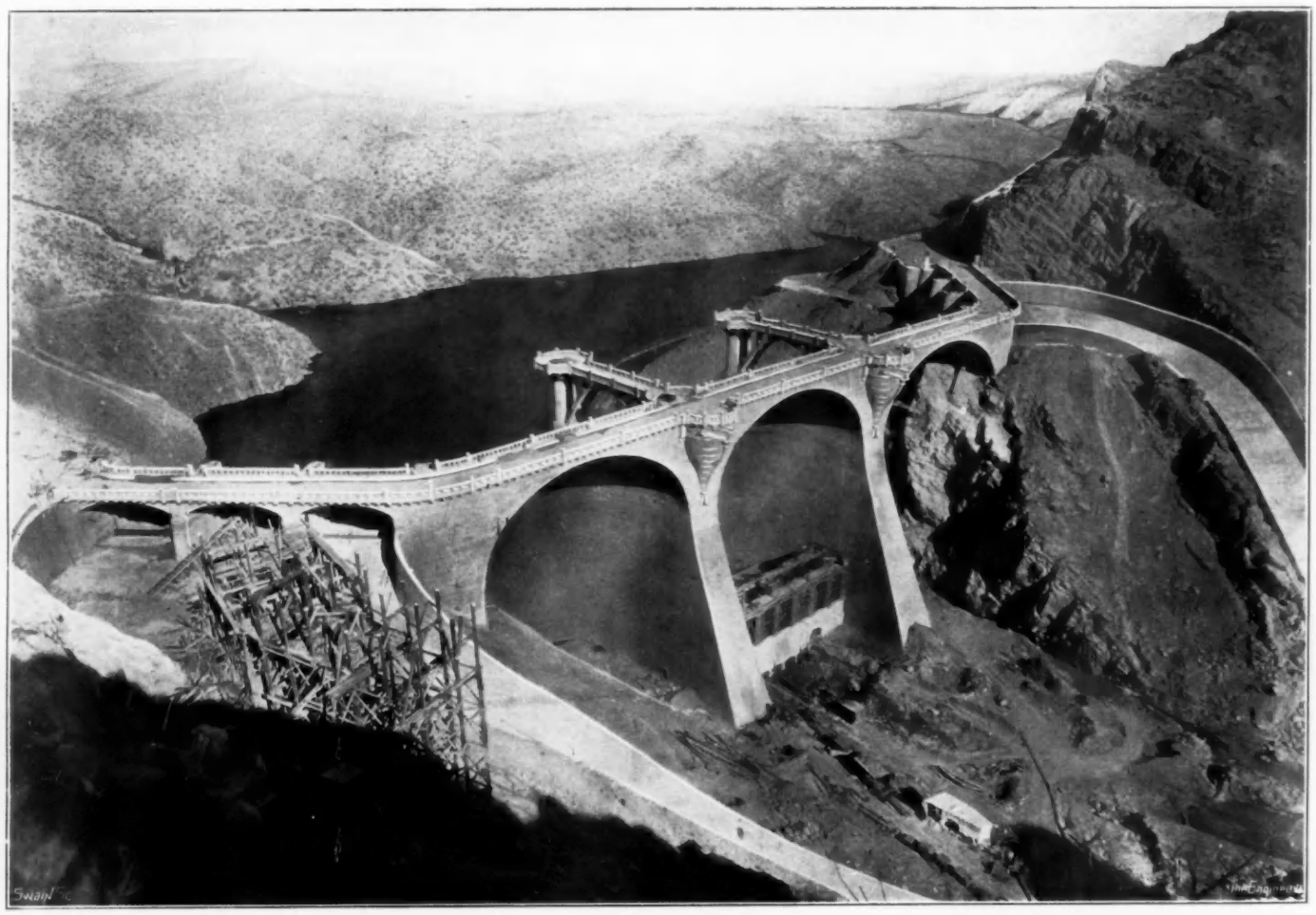
The Coal Trade.

The recent firmness in the Northern coal trade is well maintained. There are some doubts whether the present active demand for coals will last, but for the present at least the position is quite favourable. In fact, the outlook up to March is very satisfactory. Large quantities of coal have been sold over varying periods this year, and the cheering circumstance about it is that buyers are inclined to increase their commitments, though they have to pay more than when they negotiated their earlier supplies. The same remark applies to coke, very large supplies of which were sold last year at figures that would not be entertained at the present time. The demand for all grades of coal is extremely well maintained, and fitters find that, if they can provide a loading turn where a boat is available, they can obtain more than current prices. There have been several instances during the last few days of buyers being prepared to pay more for the coal if they could be assured of prompt loading. Loading turns are very full, and this is preventing the acceptance of all the business that is being offered. It is in every way likely

THE COOLIDGE IRRIGATI



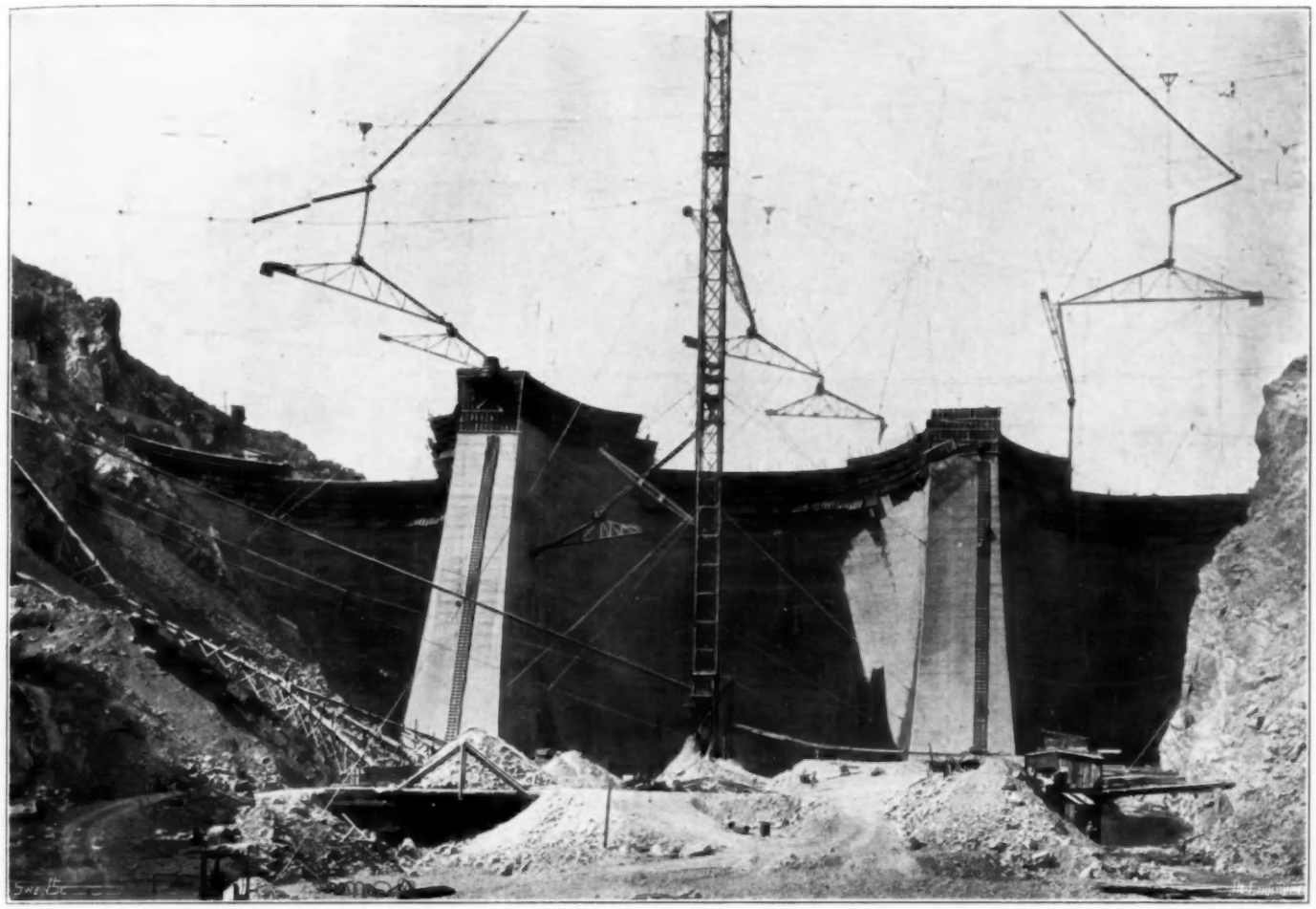
UPSTREAM FACE OF DAM, NEARING COMPLETION



DOWNSTREAM FACE OF DAM, SHOWING SPILLWAYS AND POWER-HOUSE

UNIV. OF MICH.

IGATION DAM IN ARIZONA



DOWNSTREAM FACE OF DAM DURING CONSTRUCTION, SHOWING CONCRETING CHUTES

VIEW ALONG TOP OF DAM

that values in February for most classes of coal and coke will be as firm as they are now, so that the new year may be said to be making a good start. Any increase in prices, however, might make a complete change in the position, for it is the relatively low quotations that are attracting the business in competition with other coal-producing countries. The Northumberland steam coal position is bright. Current output is fully booked up, and with numerous inquiries circulating, fitters consider that the present pressure will be maintained for some weeks ahead. Best qualities are firmly held at 14s. 6d., and seconds at 13s. 6d. Stocks of steam smalls are large, but under considerably improved demand holders adopt a firm attitude and ask 8s. 6d. to 9s. On the Durham side the steam position is equally firm, fitters quoting 15s. 9d. for large and 11s. for smalls. Other quality Durhams are finding a sustained demand, and whilst the output is fully maintained, and, in individual cases, is increasing, some pits recently idle through accidents, &c., have resumed. Special gas coals are quoted firmly at 14s. 9d. to 15s. 3d., and secondary at 13s. 6d. to 13s. 9d. There is a fairly good tone ruling the coke market. Gas cokes are well stemmed for this month, and holders are consequently quoting steadily at 18s. 6d. Patent oven cokes are in steady request, but production is ample to meet all requirements, and prices remain just steady at 18s. 3d. to 18s. 9d., but special makes and beehive cokes remain firm at 23s. 6d. to 28s. 6d.

Cleveland Miners' Wages.

During the current quarter the wages of the Cleveland ironstone miners and the limestone quarrymen will continue unchanged. The ascertained selling price of Cleveland pig iron, which governs the wages under a sliding scale, showed a variation of only 2d. per ton during the past quarter, as compared with the preceding three months, and a joint conference between the mineowners and the men's representatives agreed that wages should remain unchanged.

SCOTLAND.

(From our own Correspondent.)

Markets More Normal.

BUSINESS has again been resumed on lines similar to those pertaining prior to the New Year holidays. Generally speaking, there is no change in the situation or the outlook, but a fairly confident note is apparent in certain quarters, evidently inspired by the belief that there will be a gradual but steady improvement in trade in home and export markets.

Steel.

Practically all the steel works are again in operation. One or two usually engaged in rolling sections are still idle however. Those works closely allied to the shipbuilding industry are comparatively busy. Steel sheets of the lighter gauges are well bought, and galvanised descriptions have a good market. Tube makers also are active, plants being taxed to the utmost at present. The demand for scrap is moderate, with heavy steel quoted 65s. per ton. Prices generally are unchanged.

Iron.

The demand for iron bars has not improved, and with the condition in the industry rather unsettled, no immediate change can be expected. Since the introduction of the eight hours' day manufacturing costs have risen to such an extent that iron bars are placed at a serious disadvantage in competition with steel. This is seen in the large reduction in the output of iron. For some time past efforts have been made through the medium of the Conciliation Board to deal with the problem, the employers suggesting an extension of the working day. Negotiations have proved fruitless so far, and it has been said that there is a possibility that the Conciliation Board may be dissolved. Such an event would be deplored by all parties, as a system of regulating wages by the ascertainment of selling prices has been in operation and worked smoothly for fully thirty years. While the position, therefore, is uncertain, there are faint signs of expansion. Inquiries have been better of late, and continental competition not quite so keen as formerly. Re-rolled steel bars remain fairly active and firm in price at £7 15s. home and £7 10s. per ton export.

Pig Iron.

Makers of hematite and foundry pig iron have no difficulty in supplying all demands, despite the restricted output.

Exports and Imports.

Business at Glasgow Harbour was quiet during the past week so far as steel and iron were concerned. Only 2500 tons of iron ore, 2200 tons of chrome ore, and 1750 tons of steel and iron were unloaded. Exports of steel and iron products totalled 1750 tons and pig iron 469 tons.

Coal.

There has not been any change of importance in the coal market. Foreign inquiries are slow to expand, but home demands have improved, owing to colder weather conditions. Lanarkshire splints are very firm at the moment, supplies having become tighter owing to the recent collapse of a shaft in a Lanarkshire colliery. Ells are mostly disposed of for home consumption and only very small lots are available for shipment. Best Lothians and Fifeshire steams are well placed, but seconds are not too busy. Treble nuts are somewhat easier, but smaller sizes have improved of late. Aggregate shipments amounted to 197,737 tons against 120,159 tons in the preceding week and 196,289 tons in the same week last year.

Contract for Scottish Firm.

An order for four coal transporters has been secured by the Clyde Crane and Engineering Company, Ltd., Mossend, from the Egyptian Government, for service at Alexandria. It has been stated that although the British tender was higher than any continental tender, design has been the deciding factor.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

State of Trade.

THERE has been no development so far as the steel and iron trades are concerned, and the much longed for improvement is slow to make its appearance. In the tin-plate industry the conditions are steady, with the prospect of trade expanding. In the ship-repairing line employment, although not brisk, is well maintained; but considering the amount of tonnage now trading to South Wales ports, it is somewhat surprising to find that ship repairers are not busier. In the coal trade the conditions are certainly more satisfactory, as shipments are good, and collieries are for the most part working regularly. In some instances salesmen are getting prices above the minimum, but the quantities sold at these enhanced figures are negligible. Business is not so brisk and the demand so heavy as to justify colliery undertakings opening fresh places, so as to extend their production. Most collieries are well placed for the next fortnight or more, and in some instances for the best part of February.

Tonnage and Shipments.

It was not surprising to find that last week shipments of coal marked a further improvement, and that the quantity was nearly 440,000 tons, as compared with just under 430,000 tons the preceding week. The supply of tonnage in local docks was well maintained for the best part of the week, and on Saturday the position was that there were only eighteen idle tipping appliances, while three steamers were waiting. Fresh arrivals of steamers over the week-end resulted in there being fourteen steamers waiting to get into berth, whereas only five tips were idle, so that the situation was good. There is no doubt that a certain amount of fluctuation in supplies will be seen during the next few weeks, but at the same time the outlook for collieries is fairly good, as a very substantial amount of tonnage has been taken up for loading in this district. During the Christmas week the quantity chartered was considerably reduced, but in the first week in January the amount reported as having been taken up came to over 300,000 tons, while last week the total was over half a million tons, which is well above the recent average. Still the inquiry for tonnage on the market is fairly satisfactory, but the tightness of loading stems is having a prejudicial effect upon outward rates of freight. The Newport electricity works are reported to have covered their coal requirements over the next few months, and the Andaluces Railway of Spain has placed a contract for about 35,000 tons of large coal with one of the big South Wales combines, this coal having to be delivered at certain Spanish ports over the next three months. It is also reported that the big Italian shipping company Navagazione Generale Italiana is in the market for 50,000 tons of best Admiralty large coals for delivery at Genoa and at Buenos Aires over the next four or five months, but apart from this contract business and that for the Egyptian State Railways for 200,000 metric tons of locomotive coals, there are no notably big orders about. At the same time, the most satisfactory feature is the expansion in the general inquiry from abroad for supplies of coal for early shipment. It is this fact which has imparted so much steadiness to the trade, and with the demand for foreign coaling depôts well maintained, there are hopes that the conditions in the industry will continue good for the next few months at least.

Rail Rebates on Coal and Coke.

The Government scheme for railway freight rebates on coal and coke for iron and steel works was the subject of discussion at a special meeting of South Wales coalowners on Monday, and it was resolved that all members of the Association should again be strongly urged to retain the whole of the rebate in railway rates on coal for iron and steel works, as the relief was given solely for the benefit of the coal trade. In cases where coal or coke is delivered under contract at a price at works, the whole of the rebate which will be credited to the colliery company or the coke owner should be kept by it, and no portion should be allowed to the buyer. In those cases where coal or coke has been sold through a factor whose carriage account will be credited by the railway company with the rebate, the factor should be requested to refund the whole amount to the colliery company or the coke owner. The price under new contracts for coal or coke sold at pit or works should be increased by the amount of the rebate in railway rates, thereby ensuring that the colliery owner or coke owner obtains the full value of the relief.

Trade of South Wales.

Official returns of the Great Western Railway Company respecting seaborne traffic at the ports of Newport, Cardiff, Penarth, Barry, Port Talbot and Swansea for 1928 give the total as 34,656,293 tons, as against 37,555,566 tons for 1927 and 47,148,651 tons for 1913.

Current Business.

The tone of the steam coal market keeps very steady in all sections, though it is somewhat peculiar to find that best Admiralty large coals are not relatively as good as other descriptions. Their position is, however, likely to improve, as tonnage recently chartered should place these collieries in such a position that they will have a regular outlet for the next week or two. Dry coals are well stemmed, and sized descriptions find a ready demand, notwithstanding that the resumption of work at one or two pits has increased the supplies available. Small coals fully hold their own, and patent fuel makers are slightly better off for the moment. Pitwood is a quiet market, and supplies being freely offered, the price is about 25s. 6d.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE BRITISH PERLIT IRON COMPANY, Ltd., of 15, Victoria-street, London, S.W. 1, asks us to announce that Mr. John A. Smeeton, M.I. Mech. E., has resigned from his position as managing director of the company, but that he will still remain a director.

MR. JAMES M. DEWAR, M.I. Mech. E., M. Inst. N.A., M.I. Mar. E., asks us to announce that his office address has been changed from 1, Charing Cross, S.W. 1, to Grand Buildings, Trafalgar-square, London, S.W. 1. His telegraphic address and telephone number will remain unchanged, namely, "Dewarmina, Westrand, London," and Regent 5672, respectively.

CONTRACTS.

THE GENERAL ELECTRIC COMPANY (INDIA), Ltd., has received an order for plant and apparatus for use in connection with the water supply of Benares. The order covers plant and apparatus controlling the supply of unpurified Ganges water from the Bhadaini pumping station, which embraces a huge well, sunk in the river itself, to the filtering station at Bhelupura, and for the supply of filtered water from Bhelupura to the city.

SIR W. G. ARMSTRONG, WHITWORTH AND CO., Ltd., have received from the India Store Department—acting for the Marine Department, Burma—an order for a light-ship for service at the Baragua Flats, Rangoon. The vessel is to be fitted with the latest dissolved acetylene lighting apparatus having a 500 mm. diameter lens rotated by clockwork mechanism. Fog signalling apparatus is also to be installed.

CALENDARS, DIARIES, &c., FOR 1929.

ATLANTIC TRANSPORT LINE, 38, Leadenhall-street, E.C. 3.—Wall calendar with monthly tear-off slips.

AVONSIDE ENGINE COMPANY, Ltd., Bristol.—Wall calendar with monthly tear-off slips.

BAKELITE, Ltd., 68, Victoria-street, S.W. 1.—Bakelite desk tablet.

BRAITHWAITE AND CO., ENGINEERS, Ltd., Broadway Buildings, Westminster, S.W. 1.—Pocket diary.

BRISTOL AEROPLANE COMPANY, Ltd., Filton, Bristol.—Wall calendar with monthly tear-off sheets.

WM. BRYDE, 20, Water-street, Liverpool.—Pennsylvania Railroad calendar.

CAMBRIAN WAGON COMPANY, Ltd., Cardiff.—Calendar with daily tear-off sheets.

DEWRANCE AND CO., London, S.E. 1.—Wall calendar with daily tear-off slips.

GATINEAU ELECTRIC LIGHT COMPANY, Ltd., Ottawa, Canada.—Wall calendar with monthly tear-off sheets.

INTERNATIONAL CONSTRUCTION COMPANY, Ltd., 56, Kingsway, W.C. 2.—Wall calendar with monthly tear-off sheets.

IRONITE COMPANY, Ltd., 11, Old Queen-street, Westminster, S.W. 1.—Wall calendar with monthly tear-off sheets.

RD. JOHNSON, CLAPHAM AND MORRIS, Ltd., Trafford Park, Manchester.—Wall calendar with monthly tear-off slips.

JUNKERS-WERKE.—Wall calendar with daily tear-off sheets.

MANUFACTURERS' LIFE INSURANCE COMPANY, 1, Regent-street, London, S.W. 1.—Wall calendar with bi-monthly tear-off sheets.

OIL WELL SUPPLY COMPANY, Dashwood House, London, E.C. Pocket diary.

C. A. PARSONS AND CO., Ltd., Newcastle-on-Tyne.—Wall calendar with monthly cards.

H. J. SKELTON AND CO., Ltd., London, E.C. 1.—Calendar with daily cards.

MANCHESTER ASSOCIATION OF ENGINEERS.—The first Engineering Society's dinner of the year in Manchester was held on Friday last, January 11th, at the Midland Hotel, under the auspices of the Manchester Association, and the attendance of members and friends was well up to the average. Mr. William G. Gass, M.I. Mech. E., the President, was in the chair, and amongst the guests were the Lord Mayor of Manchester, the Mayor of Salford, and Chairmen of the other engineering institutions. A pleasant feature of the evening's proceedings was the air of optimism with regard to the coming year's trade which pervaded the speeches, and especially that of the Lord Mayor, who replied to the toast of "The City and Trade of Manchester," proposed in a thoughtful speech by Mr. Leonard F. Massey. Mr. Massey is the President of the Manchester Engineering Employers' Association, an organisation of the leading firms, the chief object of which is to create an atmosphere suitable for the settlement of differences amongst its members. Mr. Massey said that there was at present a more settled and hopeful outlook for industry than had been the case for some time. The toast of "The Manchester Association of Engineers" was entrusted to Major-General Sir Philip A. M. Nash, K.C.M.G., C.B., chairman of Metropolitan-Vickers Electrical Company, who contributed an admirable review of the position in the engineering industry. After a brief retrospect of the trade and of the history of the Manchester Association, Sir Philip went on to give his views of the needs and prospects of the future as they affect the engineering industry under the changing conditions. He said that their chief difficulty was competition with America, where, unlike Great Britain and the Continent, money was plentiful and was being applied to teaching, studying and developing industrial art. Nevertheless, he based hopes for the future on the assets which we in this country possessed in our natural location for dealing with the markets of the world and British labour—the most efficient and intelligent in the world—sound finance, integrity, and credit which no other nation possessed. Above this what was required was more confidence in ourselves, organisation and rationalisation. He said he perceived a greater desire among both employers and employed to work together amicably. Mr. Gass replied to the toast. He mentioned, in connection with the affairs of the Association, that there had recently been a decline in the number of members, which the Council had to make up. The students' section was, however, in a vigorous condition. The Society had between £5000 and £6000 invested for superannuation purposes and a treasurer who looked after the funds as though they were his own possessions. The toast "Our Guests" was proposed by Mr. Julius Frith, M.Sc., and the reply was entrusted to the Mayor of Salford. An excellent musical programme contributed greatly to a very pleasant evening's entertainment.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	17/6 to 19/–
(1) Spanish	21/–
(1) N. African	21/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 15 0	—
No. 1 Foundry	3 15 0 to 3 16 0	—
No. 3 Foundry	3 11 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 12 0	3 12 0
Cleveland—		
No. 1	3 8 6	3 8 6
Silicious Iron	3 8 6	3 8 6
No. 3 G.M.B.	3 6 0	3 6 0
No. 4 Foundry	3 5 0	3 5 0
No. 4 Forge	3 4 6	3 4 6
Mottled	3 4 0	3 4 0
White	3 4 0	3 4 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
,, ,, Foundry	3 2 6	—
(3) Northampton—		
Foundry No. 3	2 15 0 to 2 16 0	—
Forge	2 11 6 to 2 13 6	—
(3) Derbyshire—		
No. 3 Foundry	3 0 0	—
Forge	2 17 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 0 6	—
No. 4 Forge	2 17 6	—
Basic	3 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	(4) 4 0 0 (a)	—
	(4) 4 3 6 (b)	—
	(4) 4 6 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
Double Best Bars	11 5 0	—
Treble Best Bars	11 15 0	—
LANCS.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 10 0	—
Best Bars	11 0 0	—
Hoops	12 10 0	—
MIDLANDS—		
Crown Bars	9 2 6 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 10 0 to 8 17 6	—
Gas Tube Strip	10 12 6	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 12 6
Sheets (Gal. Cor. 24 B.G.)	13 10 0 .. 13 12 6 to 13 15 0	

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	7 12 6	—
Soft Billets	6 15 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0	—
Light Rails	8 5 0 to 8 10 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	8 17 6	—
,, (Small Round)	8 0 0 to 8 2 6	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6 to 8 17 6	—
,, (Lancs. Boiler)	9 12 6 to 9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	9 0 0	—
Hard Basic	8 12 6	—
Intermediate Basic	6 17 6 and 7 12 6	—
Soft Basic	6 12 6	—
Hoops	9 5 0 to 9 10 0	—
Soft Wire Rods	7 15 0	—
MIDLANDS—		
Small Rolled Bars	7 15 0 to 8 0 0	—
Billets and Sheet Bars	6 2 6 to 6 5 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 10 0 to 13 15 0	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	9 15 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/– to 18/3
Block Tin (cash)	222 15 0
,, ,, (three months)	222 2 6
Copper (cash)	74 12 6
,, (three months)	72 16 3
Spanish Lead (cash)	21 15 0
,, ,, (three months)	22 0 0
Spelter (cash)	25 17 6
,, (three months)	26 0 0
MANCHESTER—	
Copper, Best Selected Ingots	78 0 0
,, Electrolytic	79 0 0
,, Strong Sheets	102 0 0
,, Tubes (Basis Price), lb.	0 1 2½
Brass Tubes (Basis Price), lb.	0 1 0½
,, Condenser, lb.	0 1 2½
Lead, English	23 7 6
,, Foreign	22 7 6
Spelter	26 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 10 0	7/6
,, ,, 6 p.c. to 8 p.c.	£20 10 0	7/–
,, ,, 8 p.c. to 10 p.c.	£20 0 0	6/–
,, ,, Specially refined		
,, ,, Max. 2 p.c. carbon	£33 0 0	12/–
,, ,, ,, 1 p.c. carbon	£37 0 0	15/–
,, ,, ,, 0·70 p.c. carbon	£42 0 0	17/–
,, ,, ,, carbon free	1/– per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home	
	£13 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/– per unit	
,, ,, 75 p.c.	£19 0 0 scale 6/– per unit	
,, Vanadium	14/– per lb	
,, Molybdenum	4/3 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/– per lb.	

FUELS.

SCOTLAND.

(Prices not stable.)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/–
,, ,, Ell	16/–
,, ,, Splint	16/6 to 17/–
,, ,, Trebles	14/6 to 15/–
,, ,, Doubles	13/3 to 13/6
,, ,, Singles	13/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/6
,, ,, Jewel	16/6
,, ,, Trebles	16/–
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	12/9 to 13/6
Screened Navigation	18/–
Trebles	15/– to 15/6
Doubles	13/9 to 14/–
Singles	12/9
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/6 to 14/–
Secondary Steam	13/3
Trebles	15/– to 15/3
Doubles	13/9 to 14/–
Singles	12/9

ENGLAND.

	Inland.
(8) N.W. COAST—	
Steams	23/–
Household	38/6 to 51/–
Coke	22/–
NORTHUMBERLAND—	
Best Steams	14/6
Second Steams	13/6
Steam Smalls	9/–
Unscreened	12/– to 12/6
Household	21/– to 27/–
DURHAM—	
Best Gas	14/9
Second	13/3 to 13/6
Household	21/– to 27/–
Foundry Coke	18/– to 19/–
SHEFFIELD—	
Best Hand-picked Branch	26/– to 27/6 —
Derbyshire Best Bright House	23/– to 24/6 —
Best House Coal	20/6 to 21/6 —
Screened House Coal	17/– to 18/– —
,, ,, Nuts	16/– to 18/– —
Yorkshire Hards	14/6 to 16/– —
Derbyshire Hards	14/6 to 16/– —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	4/6 to 6/– —
Smalls	3/6 to 4/– —
Blast-furnace Coke (Inland)	14/6 at ovens —
Furnace and Foundry Coke (Export), f.o.b.	19/– to 19/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	19/3 to 19/6
Second Smokeless Large	18/– to 19/3
Best Dry Large	18/6 to 19/–
Ordinary Dry Large	17/6 to 18/–
Best Black Vein Large	17/9 to 18/–
Western Valley Large	17/3 to 17/6
Best Eastern Valley Large	17/– to 17/3
Ordinary Eastern Valley Large	16/6 to 16/9
Best Steam Smalls	12/9 to 13/3
Ordinary Smalls	10/6 to 12/6
Washed Nuts	18/– to 24/–
No. 3 Rhondda Large	19/6 to 20/–
,, ,, Smalls	14/– to 14/6
No. 2 ,, Large	16/– to 16/6
,, ,, Through	14/6 to 15/6
,, ,, Smalls	11/– to 12/–
Foundry Coke (export)	27/– to 37/–
Furnace Coke (export)	19/– to 21/–
Patent Fuel	20/– to 21/6
Pitwood (ex ship)	25/6 to 26/–
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	33/– to 35/–
Seconds	25/– to 29/–
Red Vein	22/– to 27/–
Machine-made Cobbles	40/– to 43/6
Nuts	36/– to 43/6
Beans	23/6 to 25/–
Peas	16/6 to 17/6
Breaker Duff	8/– to 9/–
Rubbly Culm	9/– to 9/3
Steam Coals :	
Large	17/6 to 18/6
Seconds	16/– to 17/–
Smalls	10/– to 12/6
Cargo Through	15/– to 16/–

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/– extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield, (c) Delivered Birmingham. (d) Rebate 12/6 joists and 10/– all other materials if home consumers confine purchases solely to British products

French Engineering Notes.

(From our own Correspondent in Paris.)

Trade Developments.

THERE is more activity in the metallurgical and engineering trades, and, in many cases, manufacturers are obliged to give longer dates for delivery. The system of "rationalisation" is also being carried to the extent that, in the motor car trade, certain firms are disposed to offer financial aid to small makers working for them to complete an equipment which will enable them to cheapen the cost of the particular parts they produce. In one case, at least, a firm is so far behindhand as to cause serious loss to agents, and the deficiency can only be made good with the help of outside makers. It thus appears possible that the "rationalisation" of mass production will create activity outside the big factories. One result of this activity is a demand for machine tools for automobile work, of which it is not always possible to obtain early delivery. While the situation of the engineering trades has much improved, there is naturally an increasing consumption of steel, which is reflected in the hardening of prices, and it is feared that quotations may advance, as is already the case with rods. Nevertheless, steelmakers are obliged to maintain a certain reserve, for an increase of prices at the present moment might cause trouble by fostering a belief that they may be inflated unduly when the country launches out on its vast programme of public works. Moreover, the outlook is by no means reassuring in view of the shadow that hangs over the Steel Cartel, which expires in October next, when it will have to be renewed, and the German steelmakers will insist upon being accorded a larger quota of production to which they consider they are entitled. They complain that the working of the Cartel has been detrimental to their interests, because other countries have failed to follow it up with the constitution of an international sales' organisation, which they regard as necessary to its success. So far, German steelmakers affirm that the only effect of the Cartel has been to limit the production of steel to below the home needs, and to involve them in heavy penalties for a surplus output. If the Germans fail to obtain satisfaction, they declare that they will withdraw from the Cartel. The difficulties that continue to hamper the operations of international organisations appear to jeopardize the success of the proposed European *entente* in the colliery industry, which for the moment has not advanced beyond the stage of preliminary discussion.

Water Sterilisation.

An epidemic of typhoid fever in the suburbs of Lyons is attributed by many to the water supply, which is in the hands of the Municipality and a company. Both use filter beds which, it is believed, are polluted. The company is sterilising the water with chlorine in the usual way, while the Municipality has installed at its two waterworks the Bunau-Varilla system of sterilisation by means of minute doses of chlorine. This process has been adopted in view of the results claimed to have been obtained at Rheims, Carcassonne and some other towns where it is declared to have completely suppressed epidemics of typhoid fever. Since its first introduction the process has, evidently, undergone certain modifications, for it is now understood that, at Carcassonne, the water is violently agitated when the chlorine is introduced, whereby it may be assumed that much depends upon bringing the small quantity of chlorine into intimate association with a large volume of water. Other systems are being tried, such as the ferro-chlorine process at Lectoure (Gers), in the hope of discovering some suitable method which will avoid the necessity of employing filter beds with their risks of contamination. The Paris Municipality is, for the time being, at any rate, doing nothing with the works that were installed at Saint-Maur for the ozone treatment of water. The maintenance cost is reported to be too high.

Port Equipments.

The estimates presented to the Chamber of Deputies by the Minister of Public Works provide for an expenditure, during the present year, of no less than 1686 million francs for improvements to inland waterways, roads and ports. On account of the opposition of the Minister of Finance to any increase on the previous year, the amount may be reduced, but that will merely retard the carrying out of certain works, which include the installation at the various ports of between 400 and 500 powerful cranes and elevating appliances of all kinds, which will enable an additional 20 million tons of traffic a year, or about one-half of the weight of goods at present handled, to be dealt with. It is supposed that two-thirds of the equipment can be obtained from Germany on account of reparations. The Chambers of Commerce at the different ports have issued a warning against any indiscriminate carrying out of this programme. Unless arrangements are made to specialise traffic in conjunction with the railways, much of this costly plant will be rendered useless.

Foreign Competition.

The mechanical engineering industries have developed so considerably that they employ more than a million hands, consume 45 per cent. of the home steel production, and are responsible for 19 per cent. of the total exports. These figures are given by the President of the Syndicat des Industries Mécaniques de France who, in a recent address, dealt more particularly with the effect of foreign competition on the home mechanical industries. He deprecated the idea of forming a European Customs' Union with the object of keeping out the increasingly formidable American competition, because he believed that such an arrangement would only leave the country open to the invasion of German mechanical products. Already the situation had been rendered sufficiently serious by the importation of so much material from Germany, not only on account of reparations but also through the ordinary channels of trade. Another cause of uneasiness to French manufacturers is the propaganda work carried out in Great Britain and other countries in favour of buying nothing but home-made products.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

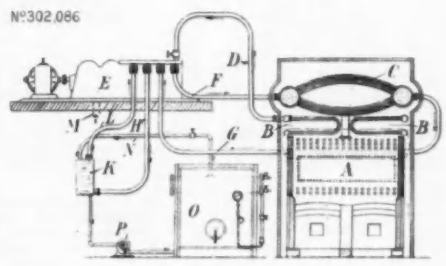
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

302,086 February 13th, 1928.—STEAM POWER SYSTEMS, *Babcock and Wilcox, Ltd., of Babcock House, Farringdon-street, London, E.C. 4.*

This invention relates to improvements in steam power systems, particularly in such systems in which the prime mover has a number of stages and in which some or all of the exhaust steam passing from one stage to another is reheated before entering the lower pressure stage. The steam boiler A is provided with superheaters B and a reheater C. Steam from the superheaters passes through the pipe D to the high-pressure stage of a multi-stage turbine E. Some or all of the exhaust from this high-pressure stage is returned through the pipe F to the reheater C, and from thence the reheated steam flows through the pipe G to a lower pressure stage of the turbine. A pipe H leads some or all of the exhaust steam from a lower pressure stage to a heater K, preferably arranged closely adjacent the turbine, and the steam reheated in the heater K passes through the pipe L to a lower pressure stage of the turbine, the exhaust steam from the turbine passing out through the pipe M. The

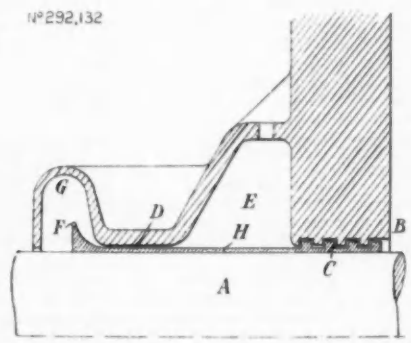


heater K is supplied with heating steam through the pipe N connected to an auxiliary boiler O, the pipe N extending continuously through the heater K to a pump P, and from thence to the boiler O. The heater K and the boiler O are in a practically closed system, so that, except for accidental losses, the amount of water in such a system will remain constant. Consequently, the boiler O will not need any special provision to supply dry steam to the heater K, and, in fact, the usual steam and water separating drum may be dispensed with in the boiler O. The pump P will be needed only to overcome the frictional resistance to the flow through the pipes, since all parts of the closed system are under the same pressure. Since the same water is circulated over and over again through this closed system, there will be little or no possibility of solids depositing in the tubes of the boiler O, which may therefore be operated at higher pressures without danger of burning the tubes. The arrangement is claimed to be particularly advantageous in cases in which it is desirable to reheat successive stages of the exhaust in the prime mover.—*December 13th*, 1928.

TURBINE MACHINERY.

292,132. June 14th, 1928.—PACKINGS FOR HIGH-SPEED ROTATING SHAFT, *International General Electric Company Incorporated, of 120, Broadway, New York, U.S.*

The shaft A is packed with respect to the inner space B of a turbine by means of a water packing having a throttling passage D, and connected in series with a labyrinth packing C. Between the two packings C and D is provided a mixing chamber E into which the water is introduced under a pressure lower than that existing at the high-pressure side of the labyrinth packing, so that steam flows through the labyrinth packing and condenses

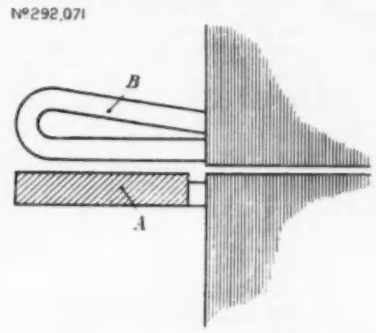


in the chamber E. The throttling passage terminates in a baffle ring F, and the water thrown off from this ring is caught by an enlargement G in the casing and led off. In order to protect the shaft from wear, an interchangeable sleeve H is provided on the shaft. Since the pressure in the turbine varies with the load, it is preferable to provide a regulating device whereby the supply of sealing liquid is regulated in accordance with the pressure within the turbine casing to be packed, and in such a manner that the pressure of the sealing liquid is always a certain amount less than the actual pressure in the turbine chamber.—*December 13th*, 1928.

DYNAMOS AND MOTORS.

292,071. June 7th, 1928.—ALTERNATING-CURRENT MOTORS WITH SHORT-CIRCUITED ARMATURES, Bergmann Elektricitäts-Werke Aktiengesellschaft, of 63-67, Seestrasse, Berlin, N. 65.

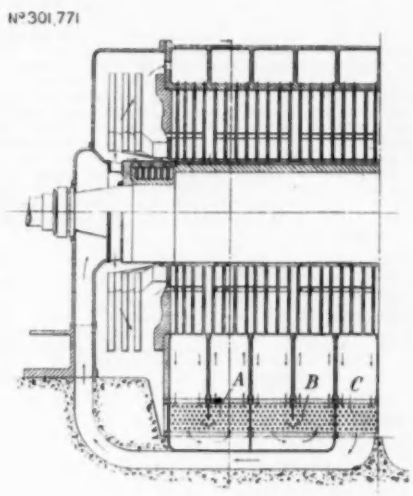
In order to obtain favourable starting conditions a squirrel cage motor constructed in accordance with this invention, has a rotor with short-circuiting rings A in the form of a cylinder, and placed as close as possible to the stator winding B. The general arrangement of the short-circuiting ring corresponds essentially to that of the stator winding. This and the short-circuiting ring form an arrangement which is very similar to a concentric transformer in which the short-circuiting ring takes the place of the inner, and the stator winding that of the outer



winding. The stator winding can be constructed with the least possible self-induction, if a two-layer winding with reduced winding pitch is used, whilst in order to reduce the magnetic leakage, the slots for the rotor should be as flat as possible.—*December 13th*, 1928.

301,771. July 5th, 1927.—THE VENTILATION OF DYNAMO-ELECTRIC MACHINERY, TRANSFORMERS, &c., Sir Charles Algernon Parsons and Jessel Rosen, both of Heaton Works, Newcastle-on-Tyne.

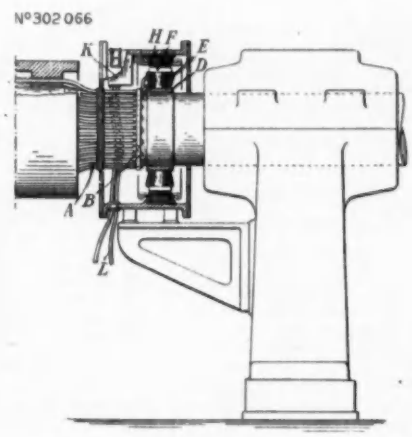
By means of this invention, instead of circulating, say 60,000 cubic feet of air per minute in an alternator with the methods of cooling hitherto employed, and with a total pressure drop of 5in. of water, a much smaller volume of air amounting to, say, 10,000 cubic feet per minute, with a consequent large decrease



in the size of the ducts, may be employed, and with a total pressure drop of 22in. of water the power required for driving the air through the system is somewhat lower in comparable cases. Owing to the reduction in size of the large external ducts, their cost and that of foundations are reduced. The gaseous cooling medium flows in series through a number of stages of the dynamo-electric machine or transformer, and is subjected to intermediate cooling between such stages in a cooler unit common to such stages and having sections A, B, C to correspond therewith.—*December 5th*, 1928.

302,066. January 3rd, 1928.—THERMO-ELECTRICALLY OPERATED DEVICES FOR THE PROTECTION OF ROTARY DYNAMO-ELECTRIC MACHINES, Electrical Improvements, Ltd., of Carliol House, Newcastle-upon-Tyne, and Herbert Bryan Poynder, of 14, Haldane-terrace, Newcastle-upon-Tyne.

The primary object of this invention is the protection against overheating of the rotors of converters or other dynamo-electric machines in automatic sub-stations. Conductors A lead from thermo-electric junctions embedded in any well-known way in



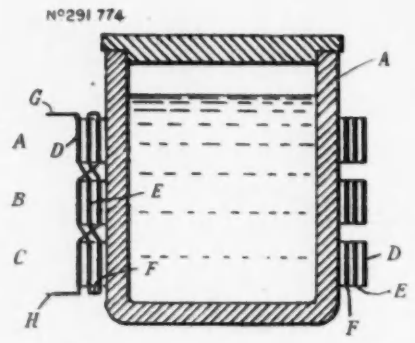
the winding of the rotor of the machine to cold junctions B. Mounted upon the shaft close to the cold junctions is an iron core D, having a winding E in series with the thermo-electric circuit. The poles F of the core are in close proximity to a small stator H, the winding of which is connected to a relay K. Connections L are shown leading from the relay. These may be

connected to any suitable exterior apparatus for indicating, for giving an alarm or for tripping purposes, but the details of these form no part of the invention.—*December 13th*, 1928.

FURNACES.

291,774. September 27th, 1927.—HIGH-FREQUENCY INDUCTION FURNACES, Siemens and Halske Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This invention relates to an arrangement of primary winding for high-frequency induction furnaces. As such, use has been made of water-cooled copper tubes or even of comparatively thick copper bands. In windings of this kind, however, the influence of the skin effect is unduly manifested, the currents on the side of the conductor at the inside of the coil becoming crowded together so that the greatest part of the cross sectional area of the conductor is not used for carrying the current, and the efficiency of the furnace is rendered comparatively bad. Actually, in the smelting of metals having a conductivity, for example, equal to that of iron it has not been possible to raise the efficiency above 70 per cent. It would be still worse if, instead of one layer of windings, several such layers were employed.

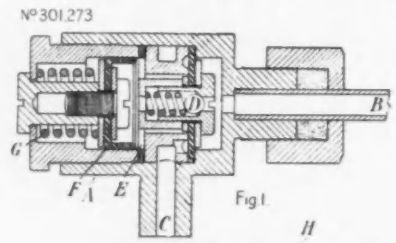


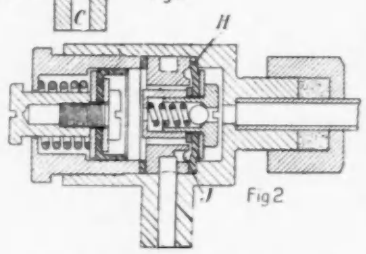
According to this invention this disadvantage is overcome by dividing the primary winding up into two or more bands set up on edge and insulated from each other. The illustration shows a crucible hearth A slightly conical in cross section, around which band-shaped conductors are wound in three turns or rings A, B, C of three layers D, E, F each. The several turns of the bands are indicated between the supply conductors G H and are connected in series in such a way that the current flows through the outer conductor D of the uppermost ring A, the middle conductor E of the next ring B, and the inner conductor F of the third ring C. From this latter it then passes into the inner conductor E and so on until it finally leaves the outer layer D of the winding in the lower winding C through the supply conductor H. The arrangements enable the efficiency of the high-frequency furnace to be increased to about 90 to 95 per cent.—*November 29th*, 1928.

MISCELLANEOUS.

301,273. May 1st, 1928.—A LUBRICATING DEVICE, H. D. Fitzpatrick, 94, Hope-street, Glasgow.

The inventor states that the object of this device is to ensure the equal distribution of a lubricant to several different points from a common source. The oil is supplied to the casing A by the branch B, and is distributed by several other branches, one of

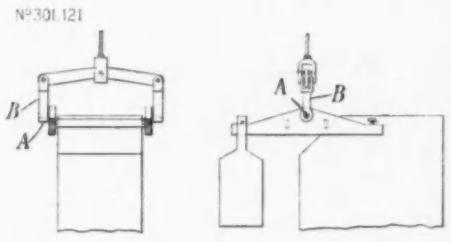




which is shown at C. On entering the casing the oil lifts the non-return ball valve D and fills the space E, forcing back the piston F against the pressure of the spring G. The pressure of the oil force pump is then relieved, the flexible diaphragm H takes up the position shown in Fig. 2, and the oil is driven out to the various branches by way of the annular passage J by the force of the spring G.—*November 29th*, 1928.

301,121. August 30th, 1928.—LEVER SYSTEMS OF WEIGHBRIDGES, T. St. J. B. Parnall, The Grand Atlantic Hotel, Weston-super-Mare.

The inventor suggests that it is difficult to get the supporting



knife-edges of a system of weighing levers properly in line. He consequently mounts the knife-edges on links, which are free to swing, and can consequently adjust themselves into alignment. In the drawing the knife-edges in question are marked A and the links supporting them B.—*November 29th*, 1928.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH GRADUATES.—At the Regent Restaurant, 51, West Regent-street, Glasgow. "Dynamometers," by Mr. J. Swan. 8 p.m.

INSTITUTION OF CHEMICAL ENGINEERS.—At the Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. "The Reactivities of Solid Carbon in Fuel Processes," by Professor J. W. Cobb. 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. General meeting. "Modern Feed Water Circuits," by Mr. J. G. Weir. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—At 39, Victoria-street, S.W. 1. Ordinary meeting. "Notes on the Fitting and Operation of Michell Bearings," by Mr. J. Foster Petree. Slides. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Further Progress in Crystal Analysis," by Sir Wm. Bragg, F.R.S. 9 p.m.

LONDON "SAFETY FIRST" COUNCIL.—Central Hall, Westminster, London, S.W. 1. "How 'Safety First' can Prevent Accidents and the Benefits to be Gained Thereby," by Mr. E. Hoult. 7 p.m.

SATURDAY, JANUARY 19TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Greenwood's Café, Todmorden-road, Burnley. Annual reunion. 5 p.m.

MONDAY, JANUARY 21ST.

BRADFORD ENGINEERING SOCIETY.—Technical College, Bradford. "Grinding Wheels and Grinding Machinery," by Mr. W. C. Bishop. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Meeting of the Scottish Centre at the Royal Technical College, Glasgow. "Safety in Four-wheel Braking Systems," by Mr. M. Platt. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Joint meeting of the Western Centre and the West of England Branch of the Institution of Mechanical Engineers, at the Merchant Venturers' Technical College, Unity-street, Bristol. "Recent Developments in the Study of the Fatigue of Materials," by Dr. H. J. Gough. 6.45 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Graduates' Section, London. Joint meeting with Students' Sections of Institution of Civil Engineers and Institution of Electrical Engineers. "Engineering Insurance," by Mr. H. R. Sketch. 6.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London W.C. 2. Cantor lecture. "The Treatment of Coal," by Dr. C. H. Lander. Lecture I. 8 p.m.

TUESDAY, JANUARY 22ND.

ILLUMINATING ENGINEERING SOCIETY.—In the Lecture Theatre of the Home Office Industrial Museum, Horseferry-road, Westminster, S.W. 1. "Colour and its Applications," by Dr. L. C. Martin, followed by a discussion. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, London, W.C. 2. London Graduates' informal meeting. "The Training of Drivers," by Mr. J. F. Ward. 7.25 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY GRADUATES.—At the Broadgate Café, Coventry. "Jigs," by Mr. Wheeler. 7.15 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineering and Scientific Club, Queen-street, Wolverhampton. Meeting. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, S.W. 1. "The Vibrations of Roads and Structures," by Messrs. James H. Hyde and H. R. Lintern. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN STUDENTS' SECTION.—Mining Institute, Neville-street, Newcastle-on-Tyne. Joint meeting with the Newcastle and District Association of the Institution of Civil Engineers. "The Development of Generation and Distribution of Electrical Power in the British Isles," by Mr. A. Page. 7.30 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "The Applications of Electro-deposited Metals to Engineering," by Mr. C. H. Faris. 7.30 p.m.

WEDNESDAY, JANUARY 23RD.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineers' Club, Manchester. "Safety in Four-wheel Braking Systems," by Mr. M. Platt. 7 p.m.

NEWCOMEN SOCIETY.—In the Rooms of the Institution of Automobile Engineers, Watergate House, Adelphi, W.C. 1. "A Chapter in the History of the Water Supply of London: A Thames-side Pumping Installation and Sir Edward Ford's Patent from Cromwell," by Mr. Rhys Jenkins. 5.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Museums and Education," by Sir Henry A. Miers, F.R.S. 8 p.m.

THURSDAY, JANUARY 24TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—In the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. "The Construction of the Grid Transmission System in Great Britain," by Messrs. Johnstone Wright and C. W. Marshall. 6 p.m.

FRIDAY, JANUARY 25TH.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN STUDENTS' SECTION.—Armstrong College, Newcastle-on-Tyne. "The City of Winnipeg Hydro-electric Power Station," by Mr. S. Gibson. 7.15 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: NORTH-EASTERN CENTRE.—Hotel Metropole, Leeds. "Pulverised Fuel Locomotive," by Mr J. Clubley Armstrong. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Informal meeting. "Measurement of Coal Supplies in Small or Large Quantities," introduced by Mr. J. E. Lee. 7 p.m.

INSTITUTION OF PRODUCTION ENGINEERS.—In the Council Room of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, London, S.W. 1. "The Designer *v.* the Production Engineer," by Mr. L. H. Pomeroy. 8 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Notes on Winches, Derricks and other Lifting Appliances Used in Modern Building Construction," by Mr. M. J. McCarthy. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "The Vegetation of Greenland," by Professor A. C. Seward, F.R.S. 9 p.m.

SATURDAY, JANUARY 26TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Gateshead-on-Tyne. General meeting. 2.45 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Southern District meeting to be held at the Town Hall, Oxford. Discussion on "Road Surfaces and a Standard of Maintenance," by Mr. H. V. Overfield; "Notes on the Construction of a New Public Convenience," by Mr. W. L. Williams. 11.15 a.m.

MONDAY, JANUARY 28TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture. "The Treatment of Coal," by Dr. C. H. Lander. Lecture II. 8 p.m.

TUESDAY, JANUARY 29TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—North British Station Hotel, Edinburgh. "Recent Extensions to Portobello Power Station," by Mr. E. Seddon. 7 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—At the Rooms of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "Errors in Testing Bulk Supply by Random Selection," illustrated by lantern slides, by Mr. H. P. Dudding. 5.30 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "The Influence of Surface Conditions and Internal Stresses on the Physical Properties of Cold-worked and Quenched and Tempered Steels, with Particular Reference to Fatigue Resistance," by Professor F. C. Lea. 7.30 p.m.

WEDNESDAY, JANUARY 30TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, S.W. 1. Students' meeting. "Design and Construction of Victoria House," by Mr. H. George Cousins. 6.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Shannon Scheme and its Economic Consequences," by Mr. George Fletcher. 8 p.m.

THURSDAY, JANUARY 31ST.

INSTITUTION OF CIVIL ENGINEERS.—Great Northern Hotel, Leeds. Annual dinner. 7 p.m.

FRIDAY, FEBRUARY 1ST.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Thomas Hawksley Lecture. "Engineering Principles in the Machinery of the Stars," by Professor A. S. Eddington, F.R.S. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Notes on Road Construction," by Mr. T. H. Cross. 7.30 p.m.

MONDAY, FEBRUARY 4TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: WESTERN CENTRE.—At the Merchant Venturers' Technical College, Unity-street, Bristol. "Coil Ignition," by Dr. F. W. Lanchester. 6.45 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture. "The Treatment of Coal," by Dr. C. H. Lander. Lecture III. 8 p.m.

CATALOGUES.

FERRANTI, Ltd., Hollinwood, Lancs.—Pamphlet T.A. 175 on transformers.

EDGAR ALLEN AND CO., Ltd., Sheffield.—Fifth edition of the "Special Alloy Tool Steels" booklet.

B. AND S. MASSEY, Ltd., Openshaw, Manchester.—Catalogue 3100 H on drop stamping plant of all types.

SUTCLIFFE, SPEAKMAN AND CO., Ltd., Leigh, Lancs.—Brochure entitled "Bricks and Brickmaking Machinery."

S. G. LEACH AND CO., Ltd., 26, Artillery-lane, E. 1.—Particulars of the "Thermodine" heating system.

HIGGS MOTORS, Witton, Birmingham.—Catalogue price list of alternating-current and direct-current motors.

HEWITTIC ELECTRIC COMPANY, Ltd., Hersham, Surrey.—Publications 105 and 106, dealing with Hewittic rectifiers.

THE HOFFMANN MANUFACTURING COMPANY, Ltd. Chelmsford.—Catalogue LC 4 of ball and roller bearings, steel balls and rollers.

W. H. A. ROBERTSON AND CO., Ltd., Lynton Works, Bedford.—"Developments in High-speed Strip Rolling," by C. L. Davies.

THE AEROGRAPH COMPANY, Ltd., 43, Holborn-viaduct, E.C. 1.—A leaflet describing the firm's new type of H.S. hand-operated spraying plant.

D. H. BONNELLA AND SON, Ltd., 46, Osnaburgh-street, N.W. 1.—Catalogue of electric lighting accessories for motor yachts, bungalows, &c.

W. RICHARDS AND SONS, Ltd., Britannia Foundry, Middlesbrough.—The ninth annual issue of the firm's chart of iron and steel prices 1914–1919.

THE SCOTTISH TUBE COMPANY, 34, Robertson-street, Glasgow.—Catalogue No. 6 in connection with main steam pipes, hydraulic tubes and tubular coils.

STANDARD TELEPHONES AND CABLES, Ltd., 63, Aldwych, W.C. 2.—Bulletin STC/82/TC 578, dealing with telephones for the office, home or factory.

W. H. WILLCOX AND CO., Ltd., 38, Southwark-street, S.E. 1.—The eighth edition of the firm's general catalogue of engineers stores, tools and requisites.

BRITISH ALUMINIUM COMPANY, Ltd., Adelaide House, King William-street, E.C. 4.—A loose-leaf pocket book giving data on aluminium sheet metal work.

L. GARDNER AND SONS, Ltd., Patricroft, Manchester.—Catalogue 513, describing the new type heavy-oil engine with compression ignition and cold starting.

BROOKHIRST SWITCHGEAR, Ltd., Chester.—Catalogues 12 and 13. "Direct-current Hand-operated Control Gear" and "Direct-current Automatic Control Gear."

W. J. FRASER AND CO., Ltd., Dagenham, Essex.—Catalogue 8, "New Economy in Drying," giving information as to the latest development in plant for drying granular products.

WILLIAM GEIPEL, Ltd., 156, Bermondsey-street, London, S.E. 1.—A leaflet describing the "Rapper," a small percussive rotating drill for making holes for the accommodation of wall plugs.

JOHNSTON BROTHERS, 79, Mark-lane, London, E.C. 3.—Publication 234 Ex., giving particulars of road-making appliances, including asphalt plants, tarmacadam plants, bitumen boilers, mixers, &c.

BATTERIES, Ltd., Redditch.—List No. 1/27, a booklet containing a semi-technical description of the construction and characteristics of the latest type "Nife" nickel-steel alkaline accumulator.